University of Alberta

Perceived tenure security and incentives for investment in Canadian forest tenures: A literature review and empirical analysis

by

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Abstract

Data from a Canada-wide survey of forest tenure holders are analyzed to estimate the influence of tenure security on perceived firm behavior and the influence of tenure attributes on both tenure security and perceived firm behavior. The influence of tenure security on perceived incentives for investment and the influence of tenure attributes on tenure security are found to be dependent on how tenure security is specified. Perceived incentives for investment in timber processing facilities are found to be influenced by overall security of tenure, security of some individual tenure attributes and by the actual values of some tenure attributes. In contrast, perceived incentives for investment in silviculture are not found to be influenced by tenure security or by tenure attributes, and are found to be mainly influenced by facility investment and the province in which companies operate.

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Table of Contents

1 Introduction	**1**
2 Literature Review	**4**
2.1 Literature Review – Canadian Forest Tenures	4
2.1.1 Costs of tenure constraints	4
2.1.2 Impacts of Canadian forest tenures on silviculture	5
2.1.3 Other studies of Canadian forest tenures	7
2.2 Literature Review – Tenure Security	8
2.2.1 Defining and Measuring Tenure Security	8
2.2.1.1 Definitions of tenure security	8
2.2.1.2 Measures of tenure security	10
2.2.2 Comparing assurance and substance definitions and measures	12
2.2.2.1 Duration of tenure as a measure of security	13
2.2.2.2 Legal title as a measure of security	14
2.2.2.3 Other security measures reflecting the substance of rights	14
2.2.3 Impacts of tenure security on investment and deforestation	15
2.2.3.1 Investment in the developed world: Canadian forest tenures	15
2.2.3.2 Investment in the developing world	16
2.2.3.3 Developing world – deforestation	19
2.2.4 Endogeneity of security	22
2.4 Summary and Conclusion	23
2.4.1 Canadian forest tenures	23
2.4.2 General literature on tenure security	24
3 Methods	**26**
3.1 Methods – Data Collection	26
3.2 Structural Equation Model (SEM) Theory	28

4 Model Specification **32**
4.1 Specification of the general model for forest tenures 32
4.2 Specification of forest tenure model to be analyzed 35
4.2.1 Estimating the tenure security – investment loop 35
4.2.2 Tenure attribute variables 37
4.2.2.1 Actual values of attributes 37
Influences of actual values of tenure attributes on tenure security 40
Influences of actual values of tenure attributes on incentives for investment in timber processing facility 41
Influences of actual values of tenure attributes on incentives for investment in silviculture 42
Other tenure attributes not included as actual values 43
4.2.2.2 Perceptions of tenure attributes 43
4.2.2.3 Provinces and position binary variables 44

5 Results and Discussion **46**
5.1 Developing the SEM 46
5.1.1 Initial estimates of actual values model 46
5.1.2 Second stage of model estimations 48
5.1.3 Adding perceptions of attributes to the models 50
5.1.4 Testing the inter-relationship of export restrictions, Saskatchewan, Manitoba, incentives for investment 51
5.2 Model Results 52
5.2.1 Model diagnostics and general model fit 52
5.2.2 Coefficient estimates 54
5.2.2.1 Tenure Security and Investment 55
5.2.2.2 Influences on tenure security 59
5.2.2.3 Influences on perceived incentives for investment in timber processing facilities 61
5.2.2.4 Influences on perceived incentives for investment in silviculture 63
5.2.3 Substance and assurance of rights in Canadian forest tenures 64

6 Summary and Conclusions 66
6.1 Assurance versus substance of rights 66
6.2 Policy recommendations 67
6.3 Limitations and further research 68

References 70

Appendix A 76

List of Tables

Table 1. Definitions of tenure security used in previous literature. Page 11

Table 2. Conclusions on the impacts of tenure security on investment. Page 19

Table 3. Conclusions on the impacts of tenure security on deforestation. Page 21

Table 4. Values of selected forest tenure attributes for provinces and tenure types included in survey sample (variables with yes/no values are binary variables equal to one for yes and zero for no). Page 38

Table 5. Expected signs of causal influence from selected forest tenure attributes to tenure security, incentives for investment in timber processing facilities and/or incentives for investment in silviculture. Page 45

Table 6. Descriptions of variable names for the Canadian forest tenures security – investment model. Page 53

Table7. Reported values for model fit statistics for the two Canadian forest tenures structural equation models (n = 100). Page 54

Table 8. Estimates of the effects in two Canadian forest tenures structural equation models (n = 110). Page 56

List of Figures

Figure 1. Path diagram for hypothetical structural equation model containing two exogenous and two endogenous variables. Page 30

Figure 2. Simplified diagram of general SEM specification for Canadian forest tenures security and investment model. Page 33

Figure 3. Histograms of survey answers to questions from which General Security and Value Change Security were derived. Page 36

Figure 4. Hypothesized causal relationship of actual values of tenure attributes for Canadian forest tenures security and investment model. Page 39

Figure 5. Final model diagram for combined actual values and perceptions model of Canadian forest tenures security and investment model. Page 41

Figure 6. Final model diagram for combined actual values and perceptions model of Canadian forest tenures security and investment model. Page 48

Figure 7. General Security Canadian forest tenures model diagram with signs and significance of estimated coefficients. Page 57

Figure 8. Value Change Security Canadian forest tenures model diagram with signs and significance of estimated coefficients. Page 58

1. Introduction

Forest policy in Canada is currently in the beginnings of a transition from sustained yield management to sustainable forest management. In the 1990s, multiple "socio-political developments coincided" signaling the beginning of a "revolutionary change" in Canadian forest management (Burton *et al.* 2003). This process of change has been driven by many factors, including: changing societal values for forests, increased environmental activism, failure of the sustained yield paradigm to achieve sustainability, changing trade patterns, and the ongoing Canada-U.S. softwood lumber dispute. In the past, forest management has focused on production of timber under the sustained yield paradigm (Luckert 1997). However, changes in the values held by society for forests are calling for the inclusion of other values in forest policy formation such as biodiversity, wildlife, recreation, aesthetics, water, and aboriginal values (Luckert and Salkie 1998; Adamowicz and Veeman 1998; Pearse 1998). This change in societal demands has been accompanied by an increase in environmental activism (from both domestic and international environmental organizations) aimed at improving the sustainability of Canada's forests. This activism has had a significant impact on the objectives of forest policy in Canada (Luckert and Salkie 1998; Haley and Luckert 1998). Changing patterns of international trade are also having a significant impact on forest policy in Canada because of the effects those changes have on the competitiveness of Canadian forestry firms. This can be seen in the Canada-U.S. softwood lumber dispute in which tariffs placed on Canadian softwood lumber exported to the U.S. degrade the competitiveness of Canadian firms (Grafton *et al.* 1998) and in the increase in availability of substitutes for Canadian lumber from plantation harvesting in nations such as New Zealand, Chile and the U.S. (Globerman *et al.* 1998).

In light of these and other factors, there has been a shift in industry and government thinking towards sustaining entire forests (sustainable forest management) instead of just sustaining timber (sustained yield) (Nelson *et al.* 2003; Luckert and Salkie 1998; Luckert 1997). This attempt by government and industry to move to sustainable forest management will have significant implications for forest policy and management goals (Globerman *et al.* 1998). However, most concepts associated with sustainable forest management have not moved beyond the idea stage to implementation in policy

(Burton *et al.* 2003; Luckert 1997) and past attempts to move toward sustainable forest management have typically come in the form of command and control regulations. For example, the BC Forest Practices Code attempted to sustain non-timber values in British Columbia forests through regulations but incurred such high costs for both industry and government that it had to be altered to reduce its restrictions on harvesting practices (van Kooten and Wang 1998).

Some argue that many of the problems facing the Canadian forestry industry today occur as a result of current tenure systems. Forest tenures are forms of property rights granted to forest companies that harvest timber on publicly owned lands in Canada. Tenures give private firms timber harvesting rights and some forest management responsibilities while attempting to ensure that public resource management and development objectives are met (Haley and Luckert 1990). Pearse (1998) suggests that the most prevailing impediment to forestry firms' incentives to manage forests in a way that enhances timber production is uncertainty of their property rights. Adamowicz and Veeman (1998) point to the fact that current tenures are too small to adequately deal with larger landscape-level issues related to sustainable forest management. Current tenure policies are also dominated by sustained yield concepts, which preclude realization of sustainable forest management objectives without significant adjustments to tenure arrangements (Luckert 1997).

The research contained in this thesis is an attempt to provide insight into the impact of Canadian forest tenures on the behavior (measured as perceptions that are theorized to affect behavior) of forestry firms in Canada through perceived incentives to invest in silviculture and timber processing facilities. It is hoped that the results of this thesis will be used to provide recommendations to provincial governments responsible for forest tenure policy. The first step in this attempt is a review of previous literature to identify key gaps in past research on forest tenures (see Chapter 2). Since this thesis will focus on security of Canadian forest tenures, a review of the literature on concepts of tenure security is also conducted to identify ways in which this study may be able to contribute to the body of literature on tenure security.

Following identification of key research needs, theoretical models of Canadian forest tenures are developed in Chapter 3. These models map how attributes of forest

tenures are thought to interact with each other and influence perceived firm behavior. These models are then empirically tested using data from a nation-wide survey of forest tenure holders. A structural equation modeling approach is used. Chapter 4 discusses the development of the models, and Chapter 5 reports and discusses the results of these model estimations.

2. Literature Review

This chapter contains two literature reviews, the first discusses literature examining forest tenures in Canada and the second discusses literature focusing on tenure security. Together these reviews will form the background for this thesis as it examines the influence of Canadian forest tenures on the forestry firms in Canada, with a focus on the determinants and influences of security of forest tenures in Canada.

2.1 Literature Review – Canadian Forest Tenures

This section includes a review of all literature found that examines the impact or influence of Canadian forest tenures on the behavior of forestry firms. Previous studies on Canadian forest tenures have mainly focused on the costs of tenure constraints or on the impacts of tenures on investment, but have also included examinations of perceived tenure security and the impacts of tenure on land value. All of the papers reviewed that carry out empirical analysis examine forest tenures in either Alberta or British Columbia.

2.1.1 Costs of tenure constraints

Cumming and Armstrong (2001; 2004), and Nanang and Hauer (2006) examined the costs of constraints resulting from overlapping tenures in Alberta. All three studies found that the removal of such constraints would decrease costs for the tenure holders. In the two studies by Cumming and Armstrong (2001; 2004), "overlapping tenures" involved a situation where seventeen coniferous Quotas were operating on the same land base as a single, large deciduous Forest Management Agreement (FMA) held by Alberta-Pacific. Cumming and Armstrong (2001; 2004) suggest an alternative "global planning" scenario in which the FMA holder would carry out all harvesting and management, while delivering required timber to the other sawmills. Their results suggest that switching to a global planning scenario could significantly reduce or eliminate predicted wood supply shortfalls and reduce long-run net delivered wood costs for the coniferous Quota holders, while being almost cost-neutral for Alberta-Pacific (Cumming and Armstrong 2001; 2004).

Alavalapati and Luckert (1997) estimate the costs of appurtenancy constraints (referred to as vertical integration requirements) and AAC (annual allowable cut)

restrictions on Quota holders in Alberta. They find that both constraints create substantial costs for Quota holders and that simultaneous elimination of both constraints would produce much larger gains than eliminating either constraint individually (Alavalapati and Luckert 1997).

Luckert (1991a; 1991b) estimated the perceived costs of tenure restrictions (1991b) and the expected costs of future increases in restrictions (1991a) for tenure holders in British Columbia. Interview survey results with high level forest managers (e.g. chief foresters) showed that most, but not all of the interviewed tenure holders believed that reducing restrictions would lower their costs and that increasing restrictions in the future would increase costs. The survey method used by Luckert (1991b, 1991a) is discussed in detail below in Section 2.1.3.

Hegan and Luckert (2000) examined the impact of changing levels of flexibility allowed around AAC levels and the impact of green-up[1] constraints on simulated returns to silvicultural investments carried out under Allowable Cut Effect (ACE)[2] policies. They found that increasing flexibility around AAC levels increased net present values from silvicultural investments, and that the presence of green-up constraints reduced returns and lessened losses from ACE policies (Hegan and Luckert 2000). Luckert and Haley (1995) had earlier examined the lack of success of ACE policies and hypothesized several tenure constraints including minimum silvicultural requirements, stumpage fee payments, uncertainty over AAC allocations and competing land claims as possible reasons for unsuccessful ACE policies.

2.1.2 Impacts of Canadian forest tenures on silviculture

Luckert (1998) used theoretical analysis and Monte Carlo simulations to show how differing levels of silvicultural requirements, reimbursements for silvicultural activities, and differing levels of equity in future timber crops can impact on silvicultural activities carried out by tenure holders. Simulation results suggested that changing tenure policies to provide incentives to invest in silviculture, rather than using regulatory

[1] Green-up constraints are requirements that a stand be fully established before an adjacent stand can be harvested (Hegan and Luckert 2000).
[2] The ACE is an immediate increase in the AAC made possible by silvicultural activities that increase expected future forest yields (Luckert and Haley 1995; Hegan and Luckert 2000).

requirements, could lead to more efficient silvicultural investment and greater wealth production (Luckert 1998).

These results are supported by several papers examining silviculture on forest tenure lands. Luckert and Haley (1990) found that companies operating on private lands (Taxation Tree Farms) in British Columbia were more willing to invest in silviculture than companies operating on public land under the Tree Farm License (TFL) form of tenure. Two subsequent papers by Zhang and Pearse (1996, 1997) also supported the above results. Zhang and Pearse (1996) compared levels of silvicultural investment on private land with various forest tenure lands (TFLs, Forest Licences (FL), and Timber Licences (TL)) in British Columbia. They found that private lands had the greatest amount of silvicultural investment followed by TFLs and FLs, with TLs having the lowest level of investment. In a later paper comparing the incidence of not satisfactorily restocked (NSR) lands, Zhang and Pearse (1997) found a similar pattern in the incidence of NSR lands for the same forms of tenure in British Columbia.

Luckert and Haley (1990) conducted a theoretical analysis of Canadian forestry firms showing that forest tenures in Canada lead firms to treat silvicultural activities as current expenditures charged against operating revenues rather than investments to increase the value of future timber resources. This is supported by a later case study of a single forest tenure holder in coastal British Columbia by Wang *et al.* (2003), who concluded that current forest policies in British Columbia encourage companies to treat silviculture as a cost of doing business, rather than as a long-term investment. A similar result is also found by Hawkins *et al.* (2006) who examined the costs of meeting forest regeneration requirements under the Forest Practices Code in British Columbia. They also concluded that the requirements of the Code led to companies viewing regeneration as a financial obligation rather than a long-term investment (Hawkins *et al.* 2006).

Luckert and Haley (1993) present a theoretical model of Canadian firms' silvicultural behavior that takes into account the institutional environment of Canadian forestry firms. They suggest that once that institutional environment is accounted for, the lack of voluntary silvicultural investment by Canadian forestry firms is rational economic behavior (Luckert and Haley 1993).

2.1.3 Other studies of Canadian forest tenures

Luckert (1991a) used surveys to examine the perceived security of tenures in British Columbia. This was done by asking respondents about their expectations of change in certain tenure characteristics over the next twenty years and how those expected changes would affect the potential benefits accrued to the tenure holder. Negative expected effects were ordered from most harmful to least harmful and positive effects from most beneficial to least beneficial. Harmfulness and beneficialness was then rated on a scale from -10 to 10 in order to give "security perception numbers". The security perceptions numbers were then compared across different tenure types in British Columbia (Luckert 1991a). This paper will be discussed further in the tenure security literature review below.

Luckert (1993) carried out a theoretical and empirical analysis of forest tenures showing that forest tenures that allow trades of property rights can lead to more successful mixed-wood management than forest tenures that do not allow such trading.

All of the papers reviewed above that conducted empirical analyses examined forest tenures in either Alberta or British Columbia. The only paper found that examined the influence of multiple forest tenure attributes on firm behavior on a national scale was Nautiyal and Rawat (1986). However, the authors did not conduct an empirical analysis, but instead carried out a theoretical analysis of entry into the forest industry and capital investment by forestry firms. They conclude that duration of tenure and likelihood of renewal are the only tenure attributes that are "crucially important" for capital investment purposes and that other tenure attributes, including AAC, stumpage fees, export restrictions and transferability do not significantly influence capital investment in processing plants (Nautiyal and Rawat 1986).

To the best of my knowledge, no previous paper has examined the influence of Canadian forest tenures on a national scale, or even on a multi-province scale, as is done in this thesis. Moreover, no previous paper has used data on multiple tenure attributes to empirically examine the influence of those attributes simultaneously.

2.2 Literature Review – Tenure Security

Security of property rights is central to the economics of development. Besley (1995) states that the evolution of property rights and their effect on investment are "central issues" in the political economy of development. Besley (1995) also suggests that specification and protection of rights are important to providing the preconditions for economic growth. Tenure security is recognized as important for the adoption and implementation of sustainable forest management (Owubah et al. 2001), which becomes especially important when considering the high rates of tropical deforestation in the developing world in recent decades (Deacon 1999). Security of tenure is also an important topic in the literature discussing forest tenure systems in Canada and the possible impacts that security has on the behaviour of Canadian forestry firms (e.g. Nautiyal and Rawat 1986; Luckert 1991a; Luckert and Haley 1990; Zhang and Pearse 1996,1997).

As a first step in ascertaining the influence of tenure security on investment and deforestation, it is useful to first summarize the variety of definitions and measures of tenure security used in the literature. This review of definitions makes it possible to move on to analyzing reported impacts and influences of tenure security. Another important aspect of this topic that will be discussed is the possible endogeneity of tenure security and investment.

2.2.1 Defining and Measuring Tenure Security

Throughout the literature, there is a wide divergence in ways that security is defined and measured. This section will discuss ways in which tenure security has been defined and measured, as well as problems associated with the gap between how it is defined and how it is measured both among and within papers.

2.2.1.1 Definitions of tenure security

According to Sjaastad and Bromley (2000), tenure security has been defined as having three parts: breadth, duration and assurance. Sjaastad and Bromley (2000) separate these three parts into two different categories, the substance of rights (breadth and duration) and the assurance of those rights. They assert that it is only the assurance

of rights and not the substance that truly determines tenure security, suggesting that two rights with identical substance could differ in assurance and therefore security (Sjaastad and Bromley 2000).

This discussion by Sjaastad and Bromley (2000) illustrates a common problem with the literature on tenure security; that is the problem of how to define security. Of the papers reviewed for this thesis, most either did not explicitly define security, leaving the reader to imply a definition based on the measures of security used in analysis (e.g. Godoy *et al.* 1998, 2001; Deacon 1994, 1999; Benin *et al.* 2005; Mendelsohn 1994; Place and Hazell 1993; Southgate *et al.* 1991), or defined security in some way related to the assurance of rights as Sjaastad and Bromley (2000) suggest is appropriate.

Many concepts of tenure security related to the assurance of rights have been used in the literature. However, differences among most of these are slight (i.e. semantic), or due to differences in the extent to which they encompass the complete assurance of a holder's rights or some portion of such assurance. Examples of concepts related to assurance used in the literature are uncertainty of rights (e.g. Sjaastad and Bromley 2000; Robinson 2005; Gavian and Fafchamps 1996; Li *et al.* 1998; Owubah *et al.* 2001; Smith 2004); probability or perceived probability of losing all or part of ones rights, including eviction and expropriation (e.g. Besley 1995; Hayes *et al.* 1997; Holden and Yohannes 2002; Otsuka *et al.* 2001; Place and Otsuka 2000, 2001, 2002; Sjaastad and Bromley 1997); uncertainty over changes in government policy (e.g. Feder *et al.* 1992); probability of extension or renewal (e.g. Nautiyal and Rawat 1986); and the expected impact of changes to various attributes of a tenure (e.g. Luckert 1991a).

However, there were also papers reviewed that defined security in terms of the substance of rights rather than the assurance of those rights. Examples of definitions describing the substance of rights included duration of rights (e.g. Zhang and Pearse 1996, 1997; Brasselle *et al.* 2002; Gavian and Fafchamps 1996); legal title to land (e.g. Feder and Onchan 1987); renewability of rights (e.g. Zhang and Pearse 1996, 1997); right to sell or transfer land (e.g. Gavian and Fafchamps 1996); and freedom of imposition from outside (e.g. Brasselle *et al.* 2002). Although some papers do consider both the assurance and substance of rights (e.g. Luckert 199a; 1991b), of all papers examined, only Gavian and Fafchamps (1996) defined tenure security in such a way as to

encompass both the assurance (uncertainty of the user's land claim) and the substance of the rights (rights to sell or transfer land and duration of possession). Table 1 lists the relevant articles reviewed and how the authors defined tenure security. Where applicable, variables used as measures for tenure security in empirical or theoretical analysis are also included in the table. Measures of tenure security are discussed further in Section 2.2.1.2.

2.2.1.2 Measures of tenure security

There are several complications that result from this wide diversity of definitions in the literature, including problems with generalizing and comparing results among studies. These problems are further compounded by the fact that many papers define tenure security in one way and then use measures of security that differ from that definition. In most, if not all cases, use of different measures probably occurs because information is not available on the preferred measures. Some authors (e.g. Place and Otsuka 2001; Li *et al.* 1998) discuss such information problems in their papers as justification for the use of different measures of security. For example, Li *et al.* (1998) discuss the fact that their use of length of time holding a plot as a measure of tenure security may be problematic and counter this by adding a dummy variable for the perception that the plot will be taken back at the end of the current crop year. Similarly, Place and Otsuka (2001) state that it would have been ideal to have information on explicit measures of security but that the necessary data were unavailable. Most authors (e.g. Brasselle *et al.* 2002; Hayes *et al.* 1997; Owubah *et al.* 2001; Zhang and Pearse 1996, 1997) however, do not justify their use of measures that are different from their provided definitions. For example, Owubah *et al.* (2001) define tenure security as confidence in rights but then go on to use capability to legally register land in the owner's name as a measure of security without providing justification for this decision.

Table 1. Definitions and measures of tenure security used in previous literature.

Authors	Definition of tenure security	Measures used in analysis
Benin et al. 2005	No definition	*Perception of tenure security
Besley 1995	Probability of expropriation	Transfer deed, previous litigation, method of acquisition, and duration of ownership
Brasselle et al. 2002	Long-term, continuous rights free from imposition or interference from outside, along with ability to reap benefits of labour and investment either in use or upon transfer to others	Categories based on use and transfer rights
Cattaneo 2001	Expected time of residence before eviction	Expected time of residence before eviction
Deacon 1994	No definition	Political stability
Deacon 1999	No definition	Political stability
Feder and Onchan 1987	Legal title to land	Legal title to land
Feder et al. 1992	Uncertainty over changes in government policy	Percieved likelihood of contract disruption and of retaining same plot
Gavian and Fafchamps 1996	Uncertainty over a user's claim to land and ability to sell or transfer land and duration of possession	Type of tenure
Godoy et al. 1998	No definition provided	Conflict with abutters
Godoy et al. 2001	No definition provided	Conflict with abutters and duration of residence
Hayes et al. 1997	Probability of eviction	Transferability of rights
Holden and Yohannes 2002	Perceived probability of losing ownership of a part or the whole of one's land	Same as definition (binary variable for secure-insecure)
Li et al. 1998	Uncertainty in land tenure	Duration and expectation that plot will be lost at end of crop year
Luckert 1991a	Expected impacts of changes in various aspects of forest tenures	Expected impacts of changes in various aspects of forest tenures
Mendelsohn 1994	No definition provided	Probability of eviction
Nautiyal and Rawat 1986	Level of uncertainty or likelihood of extension	Probability of extension
Otsuka et al. 2001	Probability of retaining rights	Tenure type
Owubah et al. 2001	Confidence in rights	Capability to legally register land
Place and Hazell 1993	No definition provided	Range of transfer rights
Place and Otsuka 2000	Probability of losing land rights	Proportion of land under different ownership types
Place and Otsuka 2001	Probability of losing land rights	Method of acquiring land
Place and Otsuka 2002	Probability of losing land rights	Tenure type
Robinson 2005	Uncertainty of land rights	Probability of eviction
Sjaastad and Bromley 1997	Perception of likelihood of losing a specific right	Probability of eviction
Sjaastad and Bromley 2000	Risk of losing rights and perception of that risk	**N/A
Smith 2004	Assurance of rights	Legal title
Southgate et al. 1991	No definition provided	Ratio of adjudicated agricultural land relative to entire study area
Zhang 1996	Deletion conditions, area vs volume based tenures and "general security"	Tenure type
Zhang and Pearse 1996	Renewability, comprehensiveness, obligation to share returns with government and scope of regulatory intervention	Tenure type
Zhang and Pearse 1997	Renewability, comprehensiveness, obligation to share returns with government and scope of regulatory intervention	Tenure type

*This paper gave no explanation of how the perception of tenure security was defined or measured.
**No analysis carried out in this paper.

Measures of tenure security used in the reviewed literature that describe the assurance of rights include probability of eviction or expropriation (e.g. Sjaastad and Bromley 1997, 2000; Mendelsohn 1994; Holden and Yohannes 2002; Li *et al.* 1998; Feder *et al.* 1992), expected time until eviction (e.g. Cattaneo 2001), probability of extension (e.g. Nautiyal and Rawat 1986), conflict with abutters or owners of adjacent lands (e.g. Godoy *et al.* 1998, 2001) and political stability (e.g. Deacon 1994, 1999). Measures of security that describe the substance of rights include range of transfer rights (e.g. Hayes *et al.* 1997; Brasselle *et al.* 2002; Place and Hazell 1993), legal land title (e.g. Feder and Onchan 1987; Smith 2004; Owubah *et al.* 2001; Besley 1995), type of land tenure or method of acquisition (e.g. Gavian and Fafchamps 1996; Otsuka *et al.* 2001; Place and Otsuka 2000, 2001, 2002; Besley 1995), duration of possession (e.g. Li *et al.* 1998; Besley 1995; Zhang and Pearse 1996, 1997), previous litigation (e.g. Besley 1995), renewability of tenure (e.g. Zhang and Pearse 1996, 1997), and obligation to share financial returns with government (e.g. Zhang and Pearse 1996, 1997).

2.2.2 Comparing assurance and substance definitions and measures

If one thinks of the assurance discussed by Sjaastad and Bromley (2000) in terms of expected utility, then the substance of a property right would be the current utility and the assurance of the right would be the expected change in utility or the expected benefit stream resulting from that right. From this point of view, it becomes easier to see that assurance aspects of a holder's rights would likely yield different empirical results than the substance of those rights would. If the holder of a right expects that their right will not change, then they would have high assurance and that right would be considered secure. Similarly, if the property right holder expects changes to their right that will make them better off, then they would still have high assurance and their right would still be secure. Alternately, if the holder expects their rights to change in such a way that they are made worse off, then they would have low assurance and their right would be insecure. This way of thinking about tenure security holds with the assurance definition of Sjaastad and Bromley (2000) and is how security is defined by Luckert (1991a).

Assurance related definitions and measures used in other papers also support the idea of thinking about tenure security in terms of expected utility. For example, the

probability of eviction (e.g. Hayes *et al.* 1997) is the probability of a complete loss of rights which would almost certainly make the right holder far worse off. Similarly, uncertainty over rights (e.g. Gavian and Fafchamps 1996) or over changes in government policy (e.g. Feder *et al.* 1992) at least partially represent the possibility of changes to a holders rights occurring such that the holder is made worse off. Conflict with abutters (Godoy *et al.* 1998, 2001) also reflects expected utility in that conflict with adjacent landholders is likely to make a land holder worse off. If one accepts that tenure security is most accurately reflected by expected utility in the form of assurance of rights, then it follows that measures representing the substance of rights rather than the assurance of those rights do not truly measure tenure security even if they are correlated with assurance.

2.2.2.1 Duration of tenure as a measure of security

Nonetheless, a number of substantive measures for security have been used in previous literature. For example, holding a right for a longer period of time (e.g. Zhang and Pearse 1996, 1997) does not reflect the probability that the right will change thus making the land holder better or worse off. In the case of contractual rights such as forest tenures in Canada, it may be the case that duration is positively correlated with security if governments administering the tenures are hesitant to make changes to the agreement until its term ends. However, provincial governments in Canada do generally have the right to change the agreements and other forest policy changes (e.g. the British Columbia Forest Practices Code) can occur that make forest tenure holders worse off no matter the duration of their tenure.

The above argument is implicitly supported by Place and Otsuka (2002) who include duration as an explanatory variable in their analysis separate from their security measure and do not discuss duration as being part of security. Li *et al.* (1998) also state that their use of length of time holding a plot as a measure of security is problematic and add expected loss of that plot to compensate for this. In discussing this issue, Smith (2004) suggests that a landowner with long duration rights but poor assurance will have different incentives than a landowner with assured but short-termed rights.

2.2.2.2 Legal title as a measure of security

While holding legal title to land may be positively correlated with security of tenure, legal title does not guarantee secure rights. For example, Place and Otsuka (2001) use legal title as a measure of security but state that it would be better to have information on explicit measures of security. The key issue is whether legal title is necessary and sufficient to ensure security of tenure. One must only look as far as Deacon's (1994; 1999) research to see that legal title is not sufficient for security of tenure. If the title is formal, legal and state enforced, but the government is not stable, then it is easy to imagine that the property rights associated with this title are likely not very secure.

Brasselle *et al.* (2002) states that maximum security can only be obtained when land is registered and protected by a legal title, suggesting that legal title is at least necessary for tenure security. However, Razzaz (1993) states that "legality of tenure is not necessarily a precondition for security of tenure". This statement by Razzaz (1993) is supported by studies in Thailand by Feder and Onchan (1987) and Feder *et al.* (1988), show that illegal squatters on public lands actually have a relatively secure tenure since they face low lifetime eviction probabilities of approximately 7.5 percent. In this situation, the Thai squatters have relatively secure tenure despite their lack of legal, government endorsed title. Place and Otsuka (2000) find a similar pattern in Uganda on lands under mailo[3] ownership. On these lands, only the landowner can obtain legal title to the land, but tenants on the land have very strong rights including protection from eviction (Place and Otsuka 2000). These findings by Deacon (1994; 1999), Feder and Onchan (1987), Place and Otsuka (2000), and Feder *et al.* (1988) suggest that not only is legal title not sufficient to ensure security of tenure, but it is not necessary for tenure security either.

2.2.2.3 Other security measures reflecting the substance of rights

Other substance measures of security used in the literature also may have some correlation with security but are not likely to completely measure or define it. For example, having complete transfer rights can provide land holders with some ability to

[3] Mailo ownership is the major form of land tenure in the Buganda region of central Uganda. Mailo lands are lands which were given by colonialists to "notables and elites" beginning in the early 1900s (Place and Otsuka 2000).

recover lost investments if their land rights are attenuated in some way, thus reducing the loss in utility from such attenuation. However, it is debatable as to how much value a right holder could gain from selling or transferring those rights if they have been attenuated. Similarly, lands held under certain types of ownership in some regions may also tend to have higher assurance than lands under different ownership schemes, however the arguments discussed above against legal title as a measure of security would likely also apply to type of land ownership as a measure.

2.2.3 Impacts of tenure security on investment and deforestation

It is important to keep the preceding discussion of different definitions and measures of tenure security in mind when examining the conclusions drawn from studies on tenure security. Conclusions based on analyses using measures of the substance of rights such as tenure type, legal title, breadth of rights or duration of rights may be best accepted as impacts of those measures and not necessarily as impacts of tenure security in general. For example if a particular study concludes that tenure security, measured as duration of tenure, increases investment, then it may be more appropriate to conclude that the duration of tenure increases investment, and not necessarily that security increases investment.

Literature concerning the impacts of tenure security is mainly divided into two categories. The first category, which is discussed in both the developing and developed worlds, is the impacts of tenure security on investment. The second category, which appears to only be discussed in a developing countries context, is the impact of tenure security on deforestation. Most of the papers reviewed state that economic theory suggests that increasing security of property rights will lead to increased investment in land (e.g. Besley 1995) and to decreased deforestation (e.g. Cattaneo 2001). The next section of this paper discusses the results of previous studies and empirical evidence regarding their hypotheses.

2.2.3.1 Investment in the developed world: Canadian forest tenures

There are few papers discussing tenure security in terms of the developed world, and all of the papers found discuss security in the context of Canadian forest tenures.

Nautiyal and Rawat (1986) use a theoretical model to show that tenure security, defined as the probability of a forest tenure being renewed for an additional term, would lead to increased capital investment in firms' timber processing plants. Luckert (1991a) goes into detail defining and measuring tenure security as a perception of tenure holders (please see the section of this thesis titled "Canadian forest tenures literature review" for a description of Luckert's (1991a) method), however the author did not measure the impacts of those perceptions on investment. Despite this, Luckert does discuss the implications of tenure security for investment in the Canadian forest industry, suggesting that the institutional risk of tenure insecurity could reduce the amount of investment in the forest industry to levels below the social optimum. This discussion is continued in Luckert and Haley (1990)[4] who use the differences in perceived security for holders of two tenure types in British Columbia as measured by Luckert (1988) as a possible reason for the differences in willingness to invest in silviculture for the two forest tenure types.

Zhang and Pearse (1996; 1997) also examine the effects of tenure security on investment in silviculture (Zhang and Pearse 1996) and on the occurrence of not satisfactorily restocked (NSR) lands in British Columbia (Zhang and Pearse 1997). These two articles conclude that tenure security is positively correlated with silvicultural investment and negatively correlated with occurrence of NSR land, although it is likely that, at least to some extent, the occurrence of NSR lands is directly attributable to lower levels of silvicultural investment. It should be noted, however, that the variables used in data analysis by Zhang and Pearse (1996; 1997) are the types of tenure, not measures of the tenure holders' assurance of their rights. As mentioned earlier, these conclusions about tenure security should therefore be viewed with caution and are most relevant to discussions of forest tenure policy within British Columbia rather than discussions on security of Canadian forest tenures in general.

2.2.3.2 Investment in the developing world

In contrast to this relative shortage of studies examining the effects of tenure security in developed nations, there is a large body of literature discussing this issue in

[4] Luckert and Haley (1990) use data from a dissertation by Luckert (1988), which also formed the basis for Luckert (1991a), Luckert (1991b).

developing countries. Security of property rights is hypothesized to increase investment through two mechanisms. The first is through freedom of expropriation or increased assurance that the investor will be able to reap the benefits of their investments (e.g. Besley 1995; Otsuka *et al.* 2001). The second mechanism is through increased access to funds that can be used for investing. The latter is hypothesized to occur because having secure, legal title allows occupants to use the land as collateral to obtain institutional credit. However, it could be argued that the second mechanism is an effect of legal title and not of tenure security since most discussion of the second mechanism in the literature only discusses legal title and not assurance of rights being used as collateral (e.g. Cattaneo 2001; Smith 2004). This follows from the previous section's discussion of whether or not legal title is an appropriate measure of tenure security. If one agrees that it is appropriate, then the second mechanism would indeed be a way in which security increases investment. Alternately, if one does not believe that legal title is an appropriate measure of tenure security, then it would follow that it is only the first mechanism that allows security to increase investment, with the second mechanism being a separate impact of legal title rather than of security.

Sjaastad and Bromley (1997) develop a theoretical model to show that tenure insecurity leads to sub-optimal incentives for investment. However, they do not support this outcome with empirical analysis. Fortunately, there are a large number of empirical studies examining the relationship between tenure security and investment in land. In Africa, Besley (1995) (Ghana), Place and Otsuka (2002) (Uganda), Smith (2004) (Zambia), Gavian and Fafchamps (1996) (Niger), and Hayes *et al.* (1997) (Gambia) all found positive relationships between tenure security and investment. Similar results were found in China by Li *et al.* (1998) and in Thailand by Feder and Onchan (1987). In contrast to these papers, Place and Hazell (1993) conclude that tenure security only had a positive impact on some (mostly long-term) improvements in some of the regions studied in Sub-Saharan Africa.

However, as I discussed before, the results of some of these studies should be taken with caution given the variables used to measure security in the analyses carried out. Of the papers reviewed that concluded positive impacts of tenure security on investment in a development context, none used measures of the assurance of land

holders' rights, but instead used measures of the substance of those rights. Results found by Place and Otsuka (2002), and Gavian and Fafchamps (1996) were for differences in agricultural investment on land held under different tenure types. Feder and Onchan (1987), and Smith (2004) found positive influences of legal title on fixed investments and land improvements respectively. Hayes *et al.* (1997) concluded that increased transferability of rights increased the propensity to make fixed investments and also increased the probability of finding trees on the tenure holder's land. The mixed results found by Place and Hazell (1993) were found using complete transfer rights as a proxy for security.

Despite this large number of papers concluding that increased security leads to increased investment, there are studies concluding that this is not always the case. For example, Otsuka *et al.* (2001) found a statistically insignificant effect of tenure type on tree planting and tree crop yields in Sumatra, and Hayes *et al.* (1997) found that the most transferable rights category had an insignificant influence on medium-term improvements, while the second most transferable category had a significant negative effect on medium-term improvements. Similarly, Feder *et al.* (1992) found that the perceived likelihood of contract disruption in the short term and perceived likelihood of retaining the same land plot in the long term only had a significant positive effect on crop related investment and housing investment in one of four regions studied in China. Holden and Yohannes (2002) found that the perception of tenure security had no significant impact on purchase of farm inputs and planting of perennials. Brasselle *et al.* (2002) concluded that there was no significant correlation between investment and the range of use and transfer rights held by farmers in Burkina Faso. Again, of the above papers, only Feder *et al.* (1992) and Holden and Yohannes (2002) used measures of security that account for the assurance of rights rather than the substance of rights. Table 2 provides a summary of conclusions on the effects of tenure security on investment in reviewed papers.

The inconsistencies in results regarding security suggest two things. First, as discussed before, these results may not always be examining the impacts of tenure security, but rather the impacts of the specific measures used, and therefore may not be directly comparable. Second, results may be highly dependent on the region in which

Table 2. Conclusions on the impacts of tenure security on investment.

Authors	Region	Proxies used in analysis	Concluded influence of security
Benin et al. 2005	Northern Ethiopia	Perception of tenure security	Security increases equal share cropping
Brasselle et al. 2002	Burkina Faso	Categories based on use and transfer rights	No significant impact on investment
Feder and Onchan 1987		Legal title to land	Higher security increased land improvements in two of three regions
Feder et al. 1992	China	Percieved likelihood of contract disruption and of retaining same plot	No significant impact on crop related investment. Positive impact on housing investment in 1 of 4 regions
Gavian and Fafchamps 1996	Niger	Type of tenure	Manure diverted to more secure fields
Hayes et al. 1997	Gambia	Transferability of rights	More secure fields more likely to be invested in and have trees planted
Holden and Yohannes 2002	Southern Ethiopia	Binary variable for perceived likelihood of loss of ownership	No significant direct effect
Li et al. 1998	China	Duration and expectation that plot will be lost at end of crop year	Increases manuring and fertilizer use
Place and Hazell 1993	Sub-Saharan Africa (Ghana, Kenya and Rwanda)	Range of transfer rights	Positive impact on some (mostly long-term) improvements in some regions
Place and Otsuka 2002	Uganda	Tenure type	Coffee tree planting less common in systems with insecure rights
Smith 2004	Zambia	Legal title	Greater fixed investment

the study is carried out. Discussion of this second reason is beyond the scope of this review. It is also quite likely that the two possibilities are jointly responsible. A third possibility that will be discussed in more detail below, is that tenure security can be caused by investment, leading to a possible reverse or reciprocal causality between investment and security.

2.2.3.3 Developing world - deforestation

Based on reviewed papers, the influence of tenure security on deforestation in the developing world is even less clear than its effect on investment and once again, conclusions from studies should be viewed in light of how tenure security was measured. In a cross section of 120 countries, Deacon (1994) found a positive relationship between political instability and deforestation, and Deacon (1999) found a similar relationship in an examination of historical records of the past 3000 years. These conclusions are also

supported by more regionally focused studies such as Cattaneo (2001) who found that expected time of residence until eviction and rate of deforestation are negatively correlated in Brazil, and Southgate *et al.* (1991) who found that the ratio of the proportion of adjudicated (legally recognized) agricultural land in the region to the proportion of adjudicated agricultural land in the entire study area decreased deforestation.

There are also studies, however, with conclusions that do not support the above results. Godoy *et al.* (1998) found conflicting results in Bolivia. They found that conflict with ranchers significantly increased deforestation, while conflict with loggers and small holders had no significant impact on deforestation. Conflict with all types of abutters (ranchers, loggers, small holders and an oil firm) was found to be jointly significant (Godoy *et al.* 1998). In a later paper, Godoy *et al.* (2001) found no significant effects of conflict with abutters or duration of residence on deforestation in Bolivia. Owubah *et al.* (2001) found that capability to register land did not significantly affect farmers' conservation decisions for natural forests and establishment of tree plantations in Ghana. In Malawi, Place and Otsuka (2001) found that method of acquiring land did significantly affect deforestation in some regions. However, the effects were positive in some regions and negative in others. In Sumatra, Otsuka *et al.* (2001) concluded that type of land ownership had no significant impact on deforestation. Table 3 provides a summary of conclusions on the effects of tenure security on deforestation in reviewed papers.

There are several potential reasons why the results in these papers do not appear to be consistent. First, as with investment, differences in results for the impact of tenure security on deforestation may be explained by differences among regions or by differences in how tenure security is measured. The only papers discussed in the previous paragraph that used measures of security that reflect the assurance of a land holder's rights are Cattaneo (2001), Deacon (1994, 1999) and Godoy *et al.* (1998, 2001), who used expected time of residence until eviction, political stability and conflict with abutters respectively. All of these papers using measures of the assurance of rights found negative correlations between security and deforestation except for Godoy *et al.* (2001) who found no significant effect.

Table 3. Conclusions on the impacts of tenure security on deforestation.

Authors	Region	Proxies used in analysis	Concluded influence of security
Cattaneo 2001	Brazilian amazon	Duration of residence	Decreases deforestation
Deacon 1994	120 countries	Political stability	Decreases deforestation
Deacon 1999	historical accounts	Political stability	Decreases deforestation
Godoy et al. 1998	Bolivia	Conflict with abutters	Conflict with all abutters jointly significant; only conflict with ranchers individually significantly increased deforestation
Godoy et al. 2001	Bolivia	Conflict with abutters and duration of residence	No significant impact
Otsuka et al. 2001	Sumatra	Tenure type	No significant impact
Owubah et al. 2001	Ghana	Capability to legally register land	No significant impact
Place and Otsuka 2001	Malawi	Method of acquiring land	Significant impacts in some regions, but with differing directions of impact
Southgate et al. 1991	Ecuador	Ratio of adjudicated agricultural land relative to entire study area	Decreases deforestation

Measures of tenure security used that reflect the substance of rights more than their assurance were duration of residence (Godoy *et al.* 2001 (in conjunction with conflict)), type of land tenure (Otsuka *et al.* 2001), capability to legally register land (Owubah *et al.* 2001), method of acquiring land (Place and Otsuka 2001) and relative proportion of adjudicated agricultural land (Southgate *et al.* 1991). As discussed in the previous section, these measures more adequately convey the substance of a holder's rights rather than the assurance of those rights, and so readers should be cautious in accepting these conclusions as impacts of tenure security on deforestation rather than impacts of the measured substance of rights. Of the papers listed above using measures of the substance of rights, all found insignificant impacts of their measures on deforestation except for Place and Otsuka (2001) who found positive correlations in some regions and negative in others.

A second explanation for the disparity in results is differences in how *investment* is defined. If one accepts the hypothesis that increased security of property rights leads to increased investment, then this could cause increased or decreased deforestation. This occurs because in some situations both planting trees and clearing forests can be viewed as forms of investment in land (Otsuka *et al.* 2001). Planting trees on land can be seen as a long term commitment to the productivity of the land (Sjaastad and Bromley 1997),

while clearing forestland can also be seen as an investment in land, especially if the land is cleared for agricultural use or to claim the land (Godoy *et al.* 2001). Angelsen (2007) discusses this issue and develops a theoretical model showing that tenure insecurity has a direct negative effect on the net present value of cleared forest land reflecting the risk of losing land and a positive indirect effect on the net present value of such land through increased rent. Angelsen (2007) concludes that it is impossible to determine the net effects of insecurity on a theoretical basis. This discussion leads directly into the next section, which attempts to answer the question of how tenure *insecurity* could lead to increased investment.

2.2.4 Endogeneity of security

It is suggested in many papers (e.g. Robinson 2005; Sjaastad and Bromley 1997; Besley 1995; Godoy *et al.* 1998, 2001; Otsuka *et al.* 2001; Place and Otsuka 2002; Southgate *et al.* 1991; Brasselle *et al.* 2002; Place and Hazell 1993) that there may be a reciprocal causality between tenure security and investment; that is, that increased security leads to more investment but also that investment can lead to increased security. Razzaz (1993) summarizes this idea by suggesting that the causality between investment and security of tenure is like that of a chicken and egg. If this reverse causality does exist, then it becomes reasonable to assume that tenure insecurity can cause increased investment if that investment allows the individual to obtain more secure rights to the land. Otsuka *et al.* (2001), for example, found that in Sumatra, relatively strong transfer rights are granted to people who clear communal forests but also to those who plant trees. Similarly, in Uganda where evicted tenants must be compensated for lost investments, high valued investments reduce the likelihood of eviction thus increasing security of tenure (Place and Otsuka 2002). However, it should be noted that tenure security may not always be a function of investment. For example, Hayes *et al.* (1997) defend there decision to model security and investment as exogenous by stating that in Gambia, tenure security is dependent on the method of acquiring land and is thus dependent on factors beyond the control of the individual.

Although many of the papers reviewed discuss the possibility that this reverse causality may exist and discuss its implications for data analysis, very few take this

endogeneity into account in their modeling. The only paper reviewed that carried out empirical analysis allowing for endogeneity of security and investment was Brasselle *et al.* (2002), who initially found that security (measured by the breadth of use and transfer rights) significantly influenced investment. However, once they allowed for endogeneity of security and investment, Brasselle *et al.* (2002) found that security had no significant impact on investment, while investment had a significant positive impact on security.

Robinson (2005) discusses the issue of endogeneity and illustrates an example in Karnataka, India where some farmers chose to invest in permanent improvements with the belief that it would reduce the likelihood that they would be evicted by government, while other farmers avoided any kind of permanent investment because of the risk of eviction. Robinson (2005) explained this behaviour using a two period game-theoretic model in which the government's decision on whether and how much to spend on evicting illegal squatters and the squatters' decision on how much to invest are dependent on each other.

The above argument casts even more doubt on the conclusions generated in many of the reviewed articles. If tenure security and investment are incorrectly treated as exogenous then results of analysis will likely be biased.

2.4 Summary and Conclusion

2.4.1 Canadian forest tenures

There is a relatively large body of literature examining Canadian forest tenures and their impacts on the behavior of forestry firms in Canada. Such studies have examined the impacts of tenure constraints, the influence of forest tenures on silviculture and have measured perceived tenure security among forest tenure holders. However, there have been no studies that have simultaneously examined the influence of multiple tenure attributes on firm behavior, nor has there been an empirical study of forest tenure holders nation-wide. Although tenure security has been measured on an individual respondent basis, no study has attempted to connect such individual security perceptions to other tenure attributes or to firm behavior.

2.4.2 General literature on tenure security

There is a wide variety of definitions and measures used to describe tenure security that can generally be classified into two categories: definitions describing the substance of rights and those describing the assurance of rights. Most authors either do not explicitly define tenure security or define it in terms of assurance and some authors suggest that security should only be assurance and not substance of rights. If tenure security is thought of in terms of expected utility then security would be more accurately measured by the assurance of rights than the substance of those rights. For example, a review of the literature suggests that while duration of tenure and legal title to land may be positively correlated with security, neither is necessary nor sufficient to ensure security of rights. Despite the above arguments, many studies have used substance related measures for security in their analyses. A few authors doing so have acknowledged that it would be better to have measures describing assurance of rights rather than substance, however most have not done so.

Reviewed papers have found conflicting and often insignificant results when examining the impacts of tenure security on investment and deforestation, partially resulting from the above divergence of measures used for security. All studies reviewed that examined the impacts of assurance on investment found no significant relationship between security and investment in land, while results for the relationship between substance measures of security and investment were conflicting both among and within studies.

Similarly, studies examining the impacts of tenure security on deforestation also found conflicting results. Some papers using assurance based measures of security found that security decreased deforestation while others found no significant relationship. Most reviewed papers that examined the influence of substance measures found insignificant results, with one paper finding positive relationships in some regions and negative relationships in others.

Two key problems with the conflicting results regarding the influence of tenure security on investment and deforestation are endogeneity of tenure security and the fact that both planting and clearing trees can be viewed as investments in land depending on the situation. Many of the reviewed papers discuss the possible endogeneity of security

and investment, but few account for this in their analyses. The only reviewed study that accounted for endogeneity in empirical analysis found no significant relationship between security and investment after initially concluding that security increased investment when they were not modeled as endogenous.

The following chapters of this thesis will attempt to partially address some of the gaps in the literature described above by examining assurance measures of tenure security in Canadian forestry on a nation-wide basis and modeling the influence of both the assurance and substance of forest tenures on incentives for investment perceived by Canadian forestry firms, while also allowing for the endogeneity of security and investment.

3. Methods

To address the gaps in the literature identified in Chapter 2, I intend to demonstrate that in the case of Canadian forest tenures, firm behavior measured as respondents' perceived incentives for investment is influenced by both the substance of tenures and the assurance of those tenures, and that the assurance of tenures is also influenced by their substance. In order to do this, it was necessary to collect data on multiple forest tenure attributes and respondents' perceptions of tenure assurance. This was done using a web-based survey and through collection of information from provincial legislation, regulations and other government sources. Analysis of forest tenure attributes, tenure security and investment by forest firms will involve considering multiple reciprocal relationships. For this reason, a structural equation modeling approach is employed using LISREL 8.72 software to estimate empirical models. An additional reason for the use of structural equation modeling and LISREL software is the inclusion of modification indices in the LISREL output. A modification index is a measure of the predicted decrease in the chi-square statistic if a single fixed parameter is relaxed and the model re-estimated (Jöreskog and Sörbom 1996, p. 31), thus providing suggestions of coefficients that could be added and would improve overall model fit. A modification index of four or greater is generally used as a cutoff for coefficients that would be statistically significant if added to the model.

The following sections of this chapter will first discuss the methods of data collection, then outline the theoretical underpinnings of structural equation modeling and finally discuss the theoretical model of Canadian forest tenures to be analyzed.

3.1 Methods – Data Collection

The survey consisted of two sections. The first section was designed for a stated preference analysis that will not be discussed in this thesis (for more information on this section, readers are referred to the M.Sc. Thesis by Lu (2007 – forthcoming)). The two sections were combined into one survey because the target sample was the same for both surveys. Analyses in this thesis comes from Section 2 of the survey, which asked respondents to answer questions specifically pertaining to a forest tenure held by their

company in the province in which the respondent worked. The types of questions asked in this section of the survey were questions about:

- the respondents' opinions on the impact of the tenure on investment, competitiveness of their company, innovation in forest practices, stability of local communities, and environmental integrity of forests,
- the respondents' expectations about possible future changes to specific attributes of the tenure,
- the importance to the respondents' company of possible future changes to the tenure,
- the importance to the respondents' company of certain aspects of the tenure,
- the respondents' expectations on possible market changes in the future.

Responses to these questions were provided on five point scales except for one question that was answered on a seven point scale. Appendix A contains an example of the survey.

The sample was identified as companies holding major forest tenures in all Canadian provinces except for Prince Edward Island. "Major forest tenures" were defined as volume-based tenures with AAC larger than 40,000 cubic meters and area-based tenures. Companies holding tenures in multiple provinces were surveyed for each province in which they held tenures. For companies holding multiple tenures within a province, we attempted to recruit respondents for each of the tenures in the province, although that was often impossible as the multiple tenures were often managed by the same people.

A total of 233 companies holding forest tenures in Canada were identified as the target sample for this survey. Of these, 50 could not be reached, 3 were closing or had recently closed down their operations, and 16 were owned by other companies, or were not actively harvesting or managing their woodlands. This left a sample of 164 companies. From those 164 companies, 22 declined to participate in the survey when first contacted and 142 agreed to complete the survey.

Data for this project were collected primarily using a web-based survey, approved by the Faculty of Agriculture, Forestry, and Home Economics Human Research Ethics Board, with several responses collected from surveys mailed to respondents or completed

at the June, 2006 Sustainable Forest Management Network Conference in Edmonton, Alberta. The data were collected from April to December of 2006.

Potential respondents were initially contacted by telephone to solicit their participation in the project. Upon agreeing to participate, an email was sent to the respondent providing the URL for the web-based survey along with ID codes to access the survey. Alternately, upon request, respondents were mailed a hardcopy of the survey.

In order to obtain a sufficient sample size for statistical purposes, whenever possible multiple respondents were recruited from each company per province. This resulted in a total of 166 surveys sent to the 142 companies who agreed to participate. Of those 166, 55 were either incomplete or not started. Several incomplete surveys did however include a complete Section 2, allowing their use in analysis for this thesis. There were also several cases where a single person from a company agreed to participate, but then passed the survey on to multiple colleagues who each answered the survey. This occurred eight times for a total of 26 responses from those eight companies. Four surveys were also completed and returned at the Sustainable Forest Management Network Conference, where surveys were handed out at a booth during the conference. It is difficult to suggest a response rate for the Conference surveys because many of the copies handed out were given to students, academics and other delegates who took them merely out of curiosity with no intention of completing them. A total of 116 surveys were completed, with 110 usable observations once missing values were omitted.

Similar surveys were also designed for provincial government representatives and community members. The results of these two surveys are not discussed in this thesis.

3.2 The General Format of Structural Equation Models

A LISREL structural equation model (SEM) is defined by the following three equations (Jöreskog and Sörbom 1996, p. 2):

The structural equation model:

$$\eta = B\eta + \Gamma\xi + \zeta \qquad (1)$$

The measurement model for y:

$$y = \Lambda_y \eta + \varepsilon \qquad (2)$$

The measurement model for x:

$$x = \Lambda_x \xi + \delta \qquad (3)$$

Where y is a p x 1 vector of observed response or outcome variables; x is a q x 1 vector of predictors or input variables; η is an m x 1 random vector of endogenous variables; ξ is an n x 1 random vector of exogenous variables; ζ is an m x 1 vector of equation errors; B, Γ, Λ_y and Λ_x are m x m, m x n, p x m and q x n matrices of estimated coefficients respectively; and ε and δ are p x 1 and q x 1 vectors of measurement errors respectively. The following minimal assumptions are assumed to be satisfied:

ε is uncorrelated with η

δ is uncorrelated with ξ

ζ is uncorrelated with ξ

ζ, ε, and δ are mutually uncorrelated

Covariance matrices are:

$$Cov(\varepsilon) = \Theta_\varepsilon (p \times p)$$

$$Cov(\zeta) = \Psi (m \times m)$$

$$Cov(\delta) = \Theta_\delta (q \times q)$$

$$Cov(\xi) = \Phi (n \times n)$$

The above assumptions imply the following form for the covariance of the observed variables:

$$\Sigma = \begin{bmatrix} \Lambda_y A(\Gamma\Phi\Gamma' + \Psi)A'\Lambda_y' + \Theta_\varepsilon & \Lambda_y A\Gamma\Phi\Lambda_x' \\ \Lambda_x\Phi\Gamma' A'\Lambda_y' & \Lambda_x\Phi\Lambda_x' + \Theta_\delta \end{bmatrix} \qquad (4)$$

Where $A = (I - B)^{-1}$

The general LISREL model is converted into a specific model by fixing and constraining the parameters that comprise the elements in Λ_y, Λ_x, B, Γ, Φ, Ψ, Θ_δ,

and Θ_ε. The elements can either be assigned specified values (fixed), unknown but required to equal one or more other unknown parameters (constrained), or unknown but not constrained (free) (Jöreskog and Sörbom 1996, p.2-6).

Figure 1 displays a simple example of a structural equation model with two exogenous variables and two endogenous variables each with a single indicator or observed variable. In this model, the exogenous variable ξ_1 causally influences only the endogenous variable η_1, while the exogenous variable ξ_2 causally influences both endogenous variables. Endogenous variable η_1 also causally influences endogenous variable η_2.

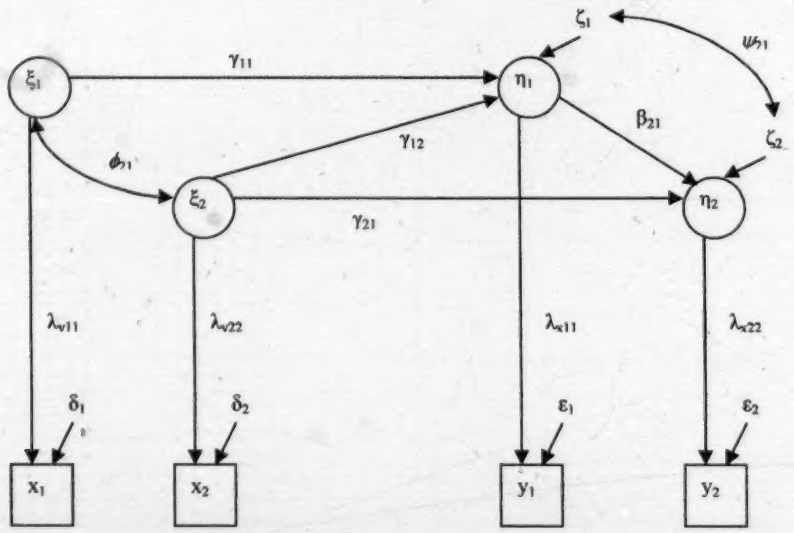


Figure 1. Path diagram for hypothetical structural equation model containing two exogenous and two endogenous variables.

Given the rules discussed above, the path diagram in Figure 1 can be written with the following equations (Jöreskog and Sörbom 1996, p.6):

The structural equations:

$$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \zeta_1 \tag{5}$$

$$\eta_2 = \beta_{21}\eta_1 + \gamma_{21}\xi_2 + \zeta_2 \tag{6}$$

The measurement model equations for y variables are:

$$y_1 = \lambda_{y11}\eta_1 + \varepsilon_1 \tag{7}$$

$$y_2 = \lambda_{y22}\eta_2 + \varepsilon_2 \quad (8)$$

The measurement model equations for x variables are:

$$x_1 = \lambda_{x11}\xi_1 + \delta_1 \quad (9)$$

$$x_2 = \lambda_{x22}\xi_2 + \delta_2 \quad (10)$$

Note that in a model such as the one displayed in Figure 1, where the η and ξ variables only have one indicator variable each, the λ_y and λ_x coefficients in equations (7), (8), (9) and (10) are set to the value one to specifiy scales of measurement for the latent variables. If the η and ξ variables had multiple indicator variables, then one λ_y and λ_x coefficient for each η and ξ variable respectively would be set to one to specify the scale for the latent variable, with the other λ_y and λ_x coefficients allowed to remain free to be estimated. The remaining parameter matrices are symmetric matrices:

the covariance matrix of ξ,

$$\Phi = \begin{bmatrix} \phi_{11} & \\ \phi_{21} & \phi_{22} \end{bmatrix} \quad (11)$$

the covariance matrix of ζ,

$$\Psi = \begin{bmatrix} \psi_{11} & \\ \psi_{21} & \psi_{22} \end{bmatrix} \quad (12)$$

the covariance matrix of ε, a diagonal matrix,

$$\Theta_\varepsilon = diag(\theta_{\varepsilon 11}, \theta_{\varepsilon 22}) \quad (13)$$

and the covariance matrix of δ, also a diagonal matrix,

$$\Theta_\delta = diag(\theta_{\delta 11}, \theta_{\delta 22}) \quad (14)$$

(Jöreskog and Sörbom 1996, p. 6-8)

Given the implied model covariance matrix Σ, shown in equation (4), LISREL uses maximum likelihood estimation to estimate the free and constrained parameters in the Λ_y, Λ_x, B, Γ, Φ, Ψ, Θ_δ, and Θ_ε matrices from the sample covariance matrix S. Starting values or initial estimates for the maximum likelihood estimation are calculated using instrumental variable and two-stage least squares methods. (Jöreskog and Sörbom 1996, p. 17)

4. Model Specification

This chapter discusses the Canadian forest tenures model to be analyzed in Chapter 5. Section 4.1 first discusses a hypothesized general model of forest tenures in Canada that is then converted to a more specific model in Section 4.2 given available data on forest tenures.

4.1 Specification of the general model for forest tenures

The general model of forest tenures analyzed in this thesis attempts to estimate the influence of selected attributes of Canadian forest tenures on the security of those tenures and on investment by forestry firms, as well as the influence of tenure security on investment. This model will provide insight into how and whether the substance of forest tenures (i.e. tenure attributes) influences the assurance (i.e. tenure security) of those tenures and how both the substance and assurance of tenures influence incentives to invest in timber processing facilities and in silviculture. Following the concepts of Sjaastad and Bromley (2000), it is expected that some aspects of the substance of tenures will affect assurance, and that both the substance and assurance of tenures will have separate influences on investment, creating a situation in which assurance is a function of substance and investment is a function of assurance and substance. Note that for the remainder of this thesis, tenure security is defined as the assurance of forest tenures and that the substance of tenures is encompassed in separate variables for tenure attributes (e.g. duration, transferability)

The forest tenures model, depicted in Figure 2, will have three "sections". The arrows in Figure 2 represent causal effects with dashed arrows representing less certain effects than the solid arrows. The first section contains three endogenous variables: tenure security, investment in timber processing facilities, and investment in silviculture. Based on the review of literature on tenure security provided in Chapter 2, it is expected that tenure security will positively influence investment in processing facilities. The influence of tenure security on investment in silviculture, however is uncertain because of the conclusions made by several authors (Luckert and Haley 1993, Wang *et al.* 2003, and Hawkins *et al.* 2006) that Canadian forestry firms view silviculture expenditures as a cost

of doing business rather than an investment. Because of this, the influence of security on investment in silviculture may be small and insignificant.

Also, as discussed in Chapter 2, the possible endogeneity of security and investment will be examined. It is hypothesized that both forms of investment may have a positive influence on tenure security. However, literature on investing to secure property rights has largely emerged from developing country situations and it is uncertain whether or not this is relevant in a developed country setting such as Canadian forest tenures, potentially resulting in the influence of investment on tenure security being small and insignificant.

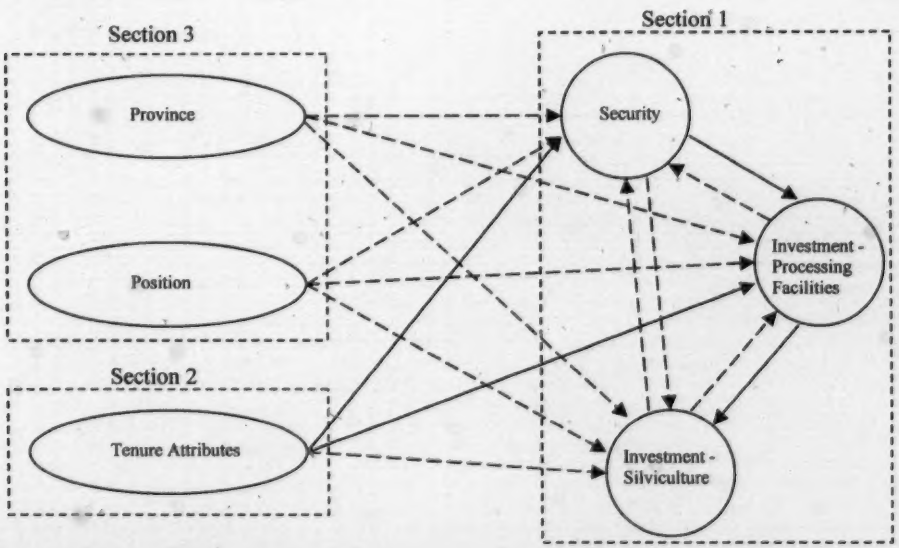


Figure 2. Simplified diagram of general SEM specification for Canadian forest tenures security and investment model.

It is also hypothesized that both forms of investment will positively influence each other. The reciprocal causality of the two investment types follows from the argument that if a firm invests in silviculture, then it will invest in facilities to process those trees. Conversely, if a firm invests in processing facilities, then the firm will invest in silviculture to supply timber to that facility. However, based on the argument that silviculture is seen as a cost for supplying a processing facility rather than as an investment, it is expected that the influence of facility investment on silvicultural

investment will be stronger than the reciprocal effect, with the reciprocal effect possibly being small and statistically insignificant. That is, it is expected that investment in processing facilities will be the major driving influence behind a firm's operations; more so than investment in silviculture. As with the uncertain influence of investment on security, the uncertain influence of silvicultural investment on facility investment is indicated by a dashed arrow in Figure 2.

The second section in Figure 2 contains exogenous variables representing various forest tenure attributes that are hypothesized to influence the investment variables and tenure security. Variables in this section will include both actual values of tenure attributes and respondents' perceptions of assurance for individual tenure attributes. The variables in the first and second sections are discussed in more detail in Section 4.2. The third section contains exogenous variables representing the province in which the tenure is held, and the level of position that the respondent holds within their company. The position variables include two binary variables, one for working in a headquarters office primarily involved in central planning, and another for working in a regional office primarily involved in operational planning. This third section is included primarily as control variables in an attempt to account for variability in the endogenous variables that is not explained by variables in the first and second sections. The variables in the third section are also included to reduce the possibility of bias in parameter estimates. Since it is difficult to predict the influences of the provincial and position variables on the endogenous variables in the first section, these influences are indicated by dashed arrows in Figure 2.

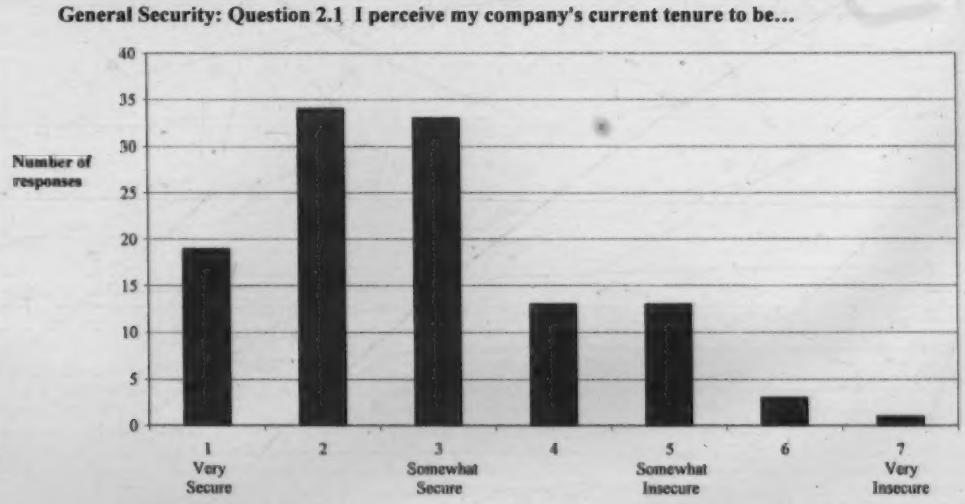
Uncertain effects indicated by dashed arrows in Figure 2 will not initially be included in the models. However, the presence of modification indices in LISREL output will indicate which of the "dashed" effects should be added to the model. However, the uncertain effect of tenure security on silvicultural investment will initially be included in the model because the relationship of security and investment is the primary point of interest in the forest tenures model analyzed in this thesis.

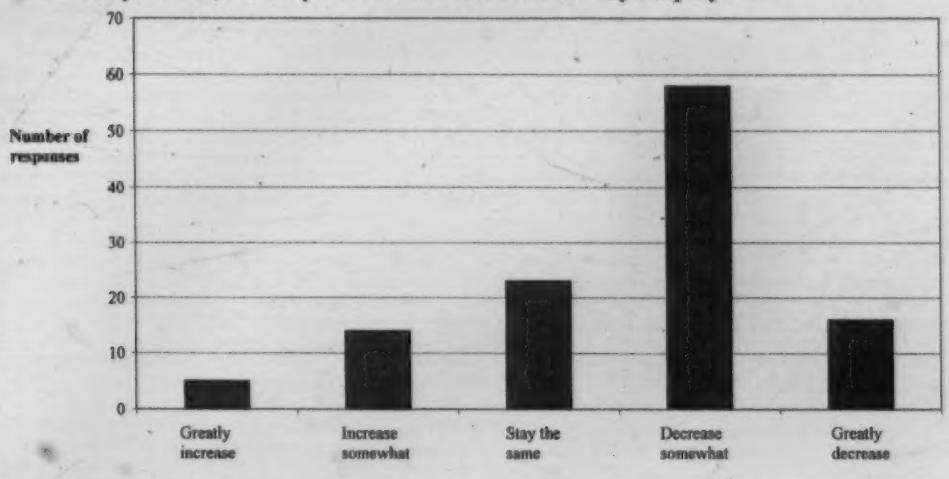
4.2 Specification of forest tenure model to be analyzed

4.2.1 Estimating the tenure security – investment loop

In order to estimate the tenure security – investment loop (section 1 of the model) shown in Figure 2, it would be ideal to have information on actual levels of investment by the firm for which the respondent works, as well as respondent specific measures of tenure security that address the assurance of the property rights defined by the tenure. The latter was captured in two ways by the survey data. The first asks respondents how secure they perceive their tenure to be (Question 2.1), answered on a seven point scale from very insecure to very secure. The second asks respondents how they believe the value of the tenure to their company will be affected by changes to the tenure made over the next twenty years (Question 2.3), answered on a five point scale from greatly decrease to greatly increase. In further discussion of these models, these two security variables will be referred to as General Security and Value Change Security respectively. General Security (perception of "security") and Value Change Security (expected impact of changes in next twenty years) will be used in separate models to test how using the different measures for security affect the causal influences estimated in the model. Figure 3 displays questions 2.1 and 2.3 of the survey from which General Security and Value Change Security were derived, along with histograms showing the distributions of the answers to those questions. Question 2.1 of the survey (General Security) was the only question in the survey that was answered on a seven point scale rather than a five point scale. This was done in order to increase variability in the answers as there was some concern that the majority of answers would be clustered at the "secure" end of the scale. Note that although General Security and Value Change Security are positively correlated with a correlation of 0.316, Figure 3 clearly shows that security or assurance measured by the General Security tends to indicate much higher levels of assurance than security measured by Value Change Security. This indicates that the term "security" may mean something different to respondents than the definition used by economists, and demonstrates the necessity for estimating separate models for the two security measures.

Figure 3. Distribution of answers to survey questions from which General Security and Value Change Security were derived.





Data on actual investments in silviculture and processing facilities for individual firms was not easily attainable and therefore was not collected. Instead, data from the survey responses will be used that measures respondents' perceptions of how their tenures influence their companies' willingness to invest in silviculture and in timber processing facilities. Respondents were presented with two statements: 1) that one or more features of the tenure negatively influence their company's willingness to invest in

silviculture (question 2.36) and 2) that one or more features of the tenure negatively influence their company's willingness to invest in their timber processing facilities (question 2.34). Respondents were then asked to provide answers on a five point scale from strongly agree to strongly disagree. For either of these variables, an answer of one (strongly agree) suggests that the respondent's tenure has poor incentives for that form of investment and an answer of five (strongly disagree) suggests that the respondent's tenure has good incentives for that form of investment.

4.2.2 Tenure attribute variables

There are two categories of tenure attribute variables included in the model: actual values of tenure attributes and perceptions of the assurance of tenure attributes. Since the actual values of tenure attributes describe the make up of a tenure, including these variables in the models will allow examination of how substance of tenures influences incentives for investment by Canadian forestry firms. The tenure security and attribute assurance variables reflect the assurance of forest tenures entail, allowing estimation of the influence of substance on assurance and of assurance on investment.

4.2.2.1 Actual values of attributes

The tenure attributes chosen for inclusion in the model were hypothesized to influence security and/or investment, and the relevant data were attainable for all provinces in the sample. The tenure attributes included in the model as actual values are: export restrictions, transferability, appurtenancy, duration of the tenure, renewability, and area-based (rather than volume-based) allotment. Table 4 displays the tenure attributes included in the model as actual values along with their values for the forest tenure types included in the sample. Hypotheses for expected influences of actual values of tenure attributes on security and investment are discussed in the proceeding section and are displayed in Table 5 and Figure 4. Recall that uncertain influences are indicated by dashed lines and, except for the influence of security on incentives for silvicultural investment, will initially be left out of the model. However, such effects may be added if modification indices indicate that they should be included in the models. Table 6 includes descriptions of the variable names used in Figures 4 and 5, and Tables 4 and 5.

Table 4. Values of selected forest tenure attributes for provinces and tenure types included in survey sample (variables with yes/no values are binary variables equal to one for yes and zero for no).

	Alberta		British Columbia		Manitoba	New Brunswick	Newfoundland	Nova Scotia	Ontario		Quebec	Saskatchewan
Tenure Type***	FMA	Quota	TFL	FL	FML	CTL	LTTL	LMA	SFL	FRL	CAAF	FMA
Export Restrictions	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Transferability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes
Appurtenancy	Yes		No	No	Yes	Yes	Yes	Yes	Some	Yes	Yes	No
Duration	20	20	25	20 or 15**	20	25	99	50	20	5	25	20
Renewability	Yes	Yes	Yes	9 obs. Yes 3 obs. No*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Area-based allotment	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

* British Columbia FLs were either FL-N's (non-renewable) or FL-R's (renewable)
** Non-renewable FL-N's have a duration of 20 years, while renewable FL-R's have a duration of 20 years but are only renewable for 15 year periods. All FL-R's were modeled as having a duration of 15 years because information on whether they were in the initial 20 year stage or had been renewed for a 15 year period was not readily available.
*** FMA: Forest Management Agreement, Quota: Timber Quota, TFL: Tree Farm License, FL: Forest License, FML: Forest Management License Agreement, CTL: Crown Timber License, LTTL: Long-term Timber License, LMA: Long-term License and Management Agreement, SFL: Sustainable Forest License, FRL: Forest Resource License, CAAF: Contract d'Approvisionnement et d'Manénagement Forestier, FMA: Forest Management Agreement.

Table 5. Expected signs of causal influence from selected forest tenure attributes to tenure security, incentives for investment in timber processing facilities and/or incentives for investment in silviculture.

	Tenure Security	Investment-facilities	Investment-Silviculture
Export Restrictions	None	None	Uncertain (-)
Transferability	Uncertain (+)*	Positive	Uncertain (+)
Appurtenancy	None	Positive	Uncertain (-)
Duration	Positive	Uncertain (+)	Uncertain (+)
Renewability	Positive	Uncertain (+)	Uncertain (+)
Area-based allotment	None	Uncertain (+)	Uncertain (+)

*Although some effects are listed as uncertain, the sign expected if the effect does exist is predicted and shown in parentheses.

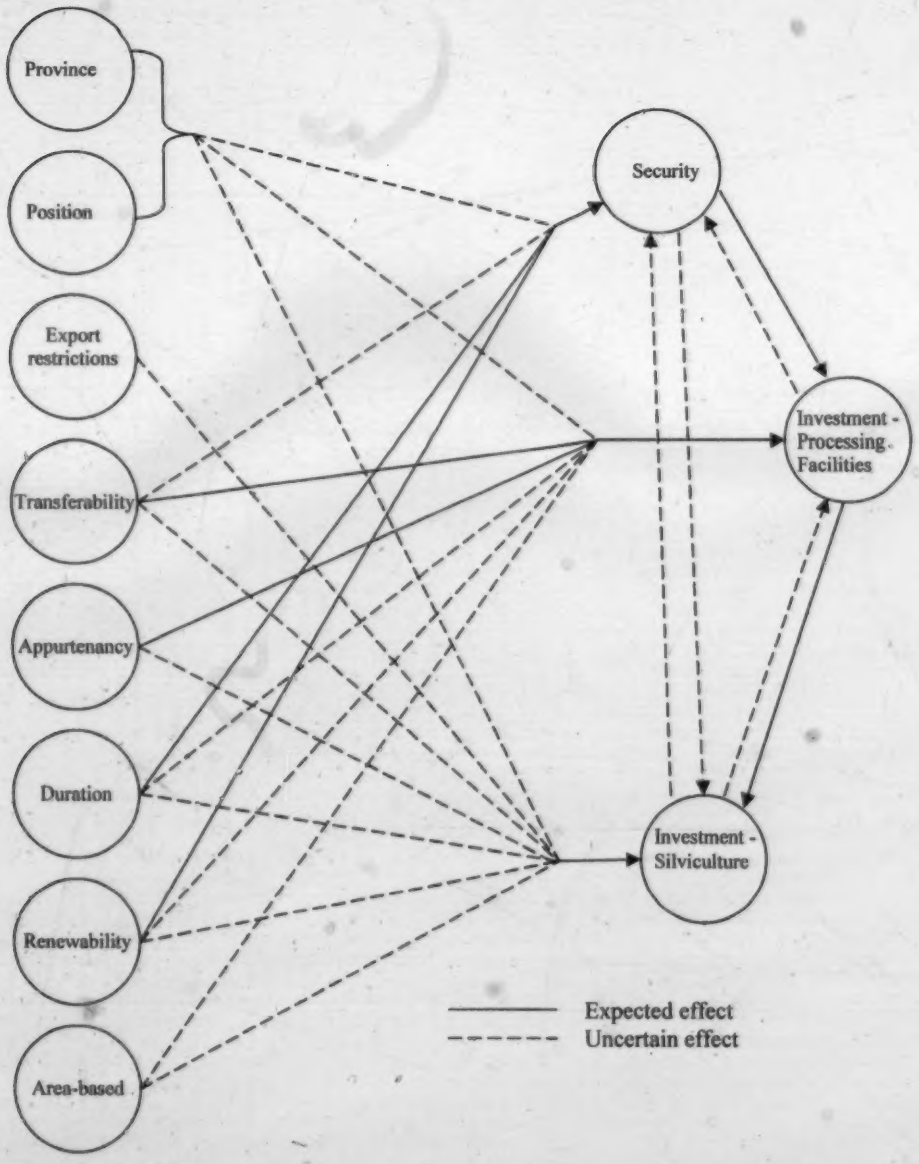


Figure 4. Hypothesized causal relationship of tenure attribute actual values, tenure security and perceived incentives for investment for Canadian forest tenures.
Note: Indicators and covariances are not shown in this diagram.

Table 6. Descriptions of variable names for the Canadian forest tenures security – investment model.

Variable Name	Variable Description
Security	General Security or Value Change Security
Invest-Facility	Perceived incentives for investment in processing facilities
Invest-Silv	Perceived incentives for investment in silviculture
Province	A group of binary variables for individual provinces (each variable equals one if the respondent is from the corresponding province: AB for Alberta, BC for British Columbia, MB for Manitoba, NB for New Brunswick, NL for Newfoundland, NS for Nova Scotia, ON for Ontario, QB for Quebec, and SK for Saskatchewan)
Position	Two binary variables for headquarters and regional positions within a company (Posit1 equals one if the respondent is in a headquarters position, Posit2 equals one if the respondent is in a regional position and both equal zero if neither position applies)
Export Restrictions	Actual value binary variable for presence of restrictions on export of unprocessed timber (equals one if the tenure is subject to export restrictions and zero otherwise)
Transferability	Actual value binary variable for right to sell the tenure (equals one if the tenure can be sold and zero otherwise)
Appurtenancy	Actual value binary variable for requirements to own/operate a timber processing facility (equals one if the tenure has appurtenancy requirements and zero otherwise)
Duration	Actual value for the length of the tenure's term (measured in years)
Renewability	Actual value binary variable for tenure renewability (equals one if the tenure is renewable and zero otherwise)
Area-based	Actual value binary variable for area-based allotment (equals one if the tenure is area-based and zero if it is volume-based)
DurationS	Perceived assurance for duration of tenure
StumpageS	Perceived assurance for stumpage fees
AACS	Perceived assurance for AAC levels
AACFlxS	Perceived assurance for flexibility allowed around AAC levels
RenewS	Perceived assurance for renewability
OpFlxS	Perceived assurance for flexibility allowed in operational requirements

Influences of actual values of tenure attributes on tenure security

If one assumes that tenure security is defined and measured as assurance of the tenure, then the only actual values of forest tenure attributes that are expected to directly influence tenure security are duration and renewability. Although provincial governments have the right to change individual tenures or an entire tenure system at any time, it is reasonable to assume that a government is most likely to make changes to an individual tenure at the time of renewal or renegotiation of that tenure. For that reason, it is hypothesized that both duration and renewability of tenure will positively influence tenure security. This is because a longer duration means a longer period of time until renegotiation of the tenure during renewal and hence a longer time until the period in which the government is most likely to enact changes to the tenure. Similarly, if a company can renew their current tenure rather than renegotiating a completely new one, the company may feel more secure that negative changes will not be imposed on them.

Export restrictions, appurtenancy requirements and area-based allotment are not expected to influence the assurance of a forest tenure and therefore are not expected to influence tenure security. The influence of transferability on security is uncertain. The right to sell a tenure may positively influence security by increasing the probability of recovering lost value resulting from increased attenuation of the tenure by selling it; however this influence may be small and insignificant because a tenure that is attenuated will likely be worth less to a potential buyer than one that is less attenuated, decreasing the amount of lost value that could be recovered through sale.

Influences of actual values of tenure attributes on incentives for investment in silviculture

The potential influences of actual values of tenure attributes on incentives for investment in silviculture are uncertain because of the argument that investment in silviculture is primarily a function of facility investment. However, if there are investment incentives in silviculture, the following relationships are hypothesized. Duration and renewability may positively influence investment in silviculture by increasing the likelihood that the company will be able reap the future benefits of those investments. However, it is possible that the impact of duration and renewability on investment will only work indirectly through security and may therefore have no direct impact on investment, Export restrictions may negatively influence silvicultural investment because restrictions on exporting unprocessed timber would reduce the capability of firms to sell their logs at the highest value, thus reducing their incentive to invest in reforestation. However, few provinces except British Columbia and the Maritime Provinces are likely to have significant opportunities for export of unprocessed timber; increasing the uncertainty for the influence of export restrictions on silvicultural investment. Appurtenancy may have a negative impact on silvicultural investment because such requirements limit the ability of firms to sell unprocessed timber; potentially reducing the value of such timber which could in turn reduce incentives to invest in silviculture. Area-based tenures may have a positive impact on investment in silviculture because holders of area-based tenures will continue to operate on the same area of land and thus will be more likely to have the opportunity to harvest the trees that

result from current silvicultural activities. In contrast, holders of volume-based tenures are less likely to operate on the same area of land in the future and therefore may not have opportunities to harvest trees resulting from their silvicultural activities.

Influences of actual values of tenure attributes on incentives for investment in timber processing facility

Transferability is expected to positively influence facility investment because the ability to sell a tenure would increase the probability of recovering the value of investments through sale of the tenure. Appurtenancy is also expected to have a positive influence on investment in processing facilities because appurtenancy clauses require a tenure holder to operate and maintain a facility thus ensuring at least some investment in those facilities.

The influences of duration and renewability on incentives for facility investment are somewhat uncertain. Renewability and longer duration could increase the likelihood that a company will be able to reap the future benefits of investments, although it is also possible that, like with investment in silviculture, the impact of duration and renewability on investment will only work indirectly through security. Similarly the influence of area-based allotment on investment in facilities is also uncertain. Where a company harvests in relation to the location of its mill does influence costs which could lead to the allotment type (i.e. volume-based versus area-based) influencing incentives for investment in processing facilities. However, volume-based tenures are typically kept within the same general management area thus minimizing this influence, which in turn would minimize the effect of allotment type on incentives for investment in processing facilities.

Export restrictions are not expected to influence incentives for investment in facilities because any such impacts would only occur if silvicultural investment is decreased by export restrictions. In this case the influence on facility investment would act indirectly through changes in silvicultural investment rather than being a direct effect from export restrictions to facility investment.

Other tenure attributes not included as actual values

Other attributes of tenures that would be expected to influence security and/or investment such as annual allowable cut (AAC), stumpage fees, and flexibility allowed in operational practices are not included in the model as actual values because data were not available for all provinces in the sample.

4.2.2.2 Perceptions of tenure attributes

Some of the additional attributes of interest discussed above for which actual value data were not available can be added to the model by using perceptions of tenure attributes. The attributes for which perception data were available from the survey are duration, renewability, AAC, flexibility allowed around AAC levels, flexibility allowed in operational requirements, and stumpage fees. For each of these attributes, respondents were asked how they think the value of the tenure to their company would change in the next twenty years as a result of changes to that attribute, answered on a five point scale from greatly decrease to greatly increase. These values will now be referred to as attribute assurance variables. Figure 5 adds the hypothesized causal relationship among attribute assurances, tenure security and investment to the model in Figure 4. As with Figures 2 and 4, uncertain effects are indicated in Figure 5 by dashed arrows.

It is expected that all attribute assurances will positively influence tenure security. However some attributes may be unimportant and therefore their influence may be statistically insignificant. No attribute assurances are expected to have negative influences on tenure security. It is uncertain whether any attribute assurances will affect the investment variables because the investment variables indicate current incentives under the tenure and the attribute assurance values represent expected future changes to the tenure. Thus, attribute assurance variables may not directly influence either of the investment variables, but instead influence investment indirectly through tenure security. However, it is possible that respondents considered future expectations for investment incentives when answering the investment questions rather than only considering current incentives. Therefore it is possible that there will be some significant influences of attribute assurance levels on investment. As with influences on security, any significant

influences on investment incentives should be positive as it is unlikely that an expected change that makes a company better off would cause worse incentives for investment.

4.2.2.3 Provinces and position binary variables

It is difficult to hypothesize which provincial and position binary variables will have impacts on tenure security and either investment type. Therefore, no causal influences from these variables were initially added to the model. If modification indices for any of these influences were close to or greater than four (the level at which freeing a parameter is expected to significantly improve model fit), then the influences were added to the model. Again, the uncertain influences of province and position are indicated by dashed arrows in Figure 5.

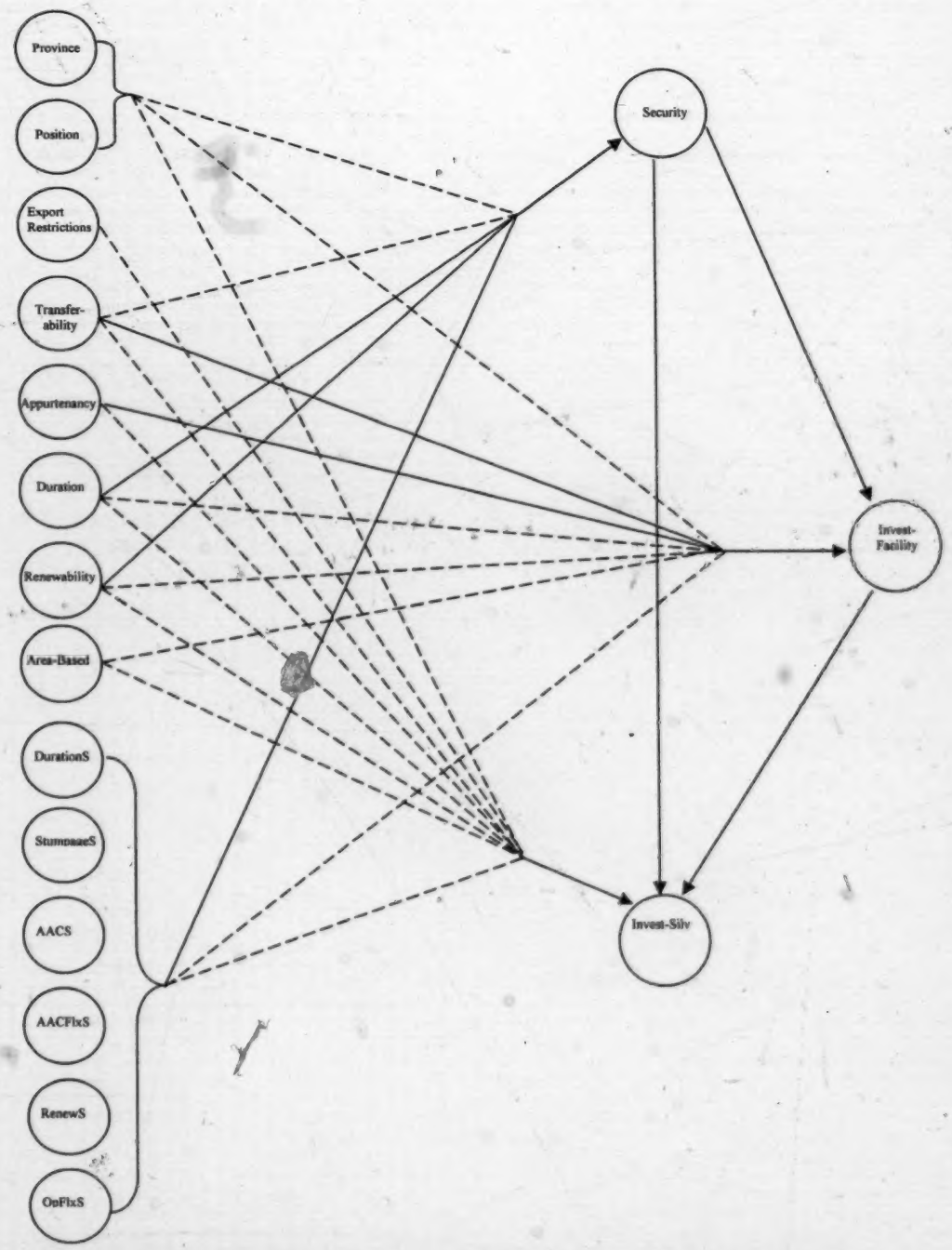


Figure 5. Hypothesized causal relationship of tenure attribute perceptions and actual values, tenure security and perceived incentives for investment for Canadian forest tenures.

Note: Indicators and covariances are not shown in this diagram.

5. Results and Discussion

5.1 Developing the SEM

The small sample size (116 observations) constrains the number of parameters that could be estimated in the model and therefore it was necessary to use initial models based on theory and then use a nested model approach to find a model that fits well, is consistent with theory and reduces the number of parameter estimates to fewer than the number of observations or as close as possible. The nested model approach was used by Hailu *et al.* (2005). The following is an outline of the SEM development process discussed in detail in this section of the thesis.

5.1.1 Initial model estimations including only the actual values for attributes to test the security – investment reciprocal loop, simplify the loop and check for potential coefficient additions based on modification indices.

5.1.2 Re-estimate the model with new coefficients and remove insignificant coefficients and exogenous variables that do not significantly influence any endogenous variables.

5.1.3 Add perceptions of attributes to the model and re-estimate. Remove insignificant coefficients and exogenous variables that do not significantly influence any endogenous variables.

5.1.4 Examine the relationship among export restrictions, Saskatchewan, Manitoba and incentives for investment in silviculture by re-estimating the models with different combinations of export restrictions, Saskatchewan and Manitoba causally influencing silvicultural investment.

5.1.1 Initial estimates of actual values model

Because of the small sample size and resulting low degrees of freedom it was decided to estimate simpler initial models to identify the causal influences within the security – investment reciprocal loop with only selected exogenous variables included. In order to estimate a reciprocal loop, it is necessary that each variable in the loop have at least one causal variable that does not directly causally influence the variable at the other end of the loop. Because all of the attribute assurance variables were hypothesized to influence tenure security and not the investment variables, the initial estimations were

carried out using only the actual values of attributes creating a model based on Figure 4 in Chapter 4. As mentioned in Chapter 4, these models were estimated with most coefficients indicated by dashed arrows omitted. These parameters were included in subsequent estimations if modification indices indicated that they should be included. The General Security (perceived "security") model had a χ^2 of 50.2 with 35 degrees of freedom for $p = 0.0459$, while the Value Change Security (expected impacts of future changes to the tenure) model had a χ^2 of 57.6 with 35 degrees of freedom for $p = 0.0093$ suggesting that neither initial model fit the data covariance matrix well.

The influence of security on both incentives for facility investment and silvicultural investment, and the influence of incentives for investment in facilities on silvicultural investment incentives were positive in both models. However, in both models the influence of silvicultural investment on investment in facilities was negative and insignificant. The unexpected negative influence of incentives for silvicultural investment on incentives for investment in timber processing facilities was tested by removing the reciprocal coefficient for facility investment incentives influencing incentives for investment in silviculture. In both models, removal of the influence from facility investment to silvicultural investment caused the reciprocal influence to become positive and significant. The instability indicated by the change in sign suggests that the models are having difficulty estimating the reciprocal causality loop between the two investment variables. Because theory (see Section 4.1) and estimation results both suggest that the influence from silvicultural investment to investment in facilities should be the weaker of the two reciprocal influences and because of the instability in this coefficient, it was removed from the model.

The modification indices for influences from the investment variables to security were not large enough to suggest addition of these coefficients at this stage[5].

[5] Both models were also estimated at this stage with all six coefficients within the security – investment reciprocal loop estimated (see Figure 1 in Ch. 3). With this specification, the Value Change Security model did not converge until the addition of the coefficients added in the second stage of estimations, and the General Security model had problems with unacceptably large negative squared multiple correlations for the endogenous variables. Additionally, the coefficients for the influences going from the investment variables to security were negative or insignificant in both models (after convergence with additional coefficients for the Value Change Security model). These results, along with the small modification indices when the reciprocal coefficients were excluded helped to confirm that the coefficients for investment influencing security should not be included in the model.

The only modification indices[6] suggesting addition of new influences from a tenure attribute to one of the endogenous variables were for duration influencing investment in processing facilities with modification indices of 4.99 and 4.28 for the General Security and Value Change Security models respectively, and for area-based allotment influencing tenure security, with modification indices of 2.3 and 11.7 for the General Security and Value Change Security models respectively. A modification index of 2.3 would not typically warrant addition of an effect. However, effects added to either model were added to both models so that results would be directly comparable between the General Security and Value Change Security models.

The provincial binary variables initially included in the models were Alberta, British Columbia, Saskatchewan, New Brunswick and Ontario; with Quebec, Manitoba, Nova Scotia and Newfoundland forming the omitted reference group. In both the General Security and Value Change Security models, the only coefficients from a province to an endogenous variable with modification indices high enough to suggest inclusion were New Brunswick having a negative influence on investment in processing facilities (modification index of 4.3 in the General Security model and 4.8 in the Value Change Security model) and possibly Saskatchewan having a negative influence on investment in silviculture (modification indices of approximately 3.6 in both models).

5.1.2 Second stage of model estimations

Based on the results discussed above, the models were re-estimated with the addition of influences from area-based allotment to security, duration to facility investment, Saskatchewan to investment in silviculture and New Brunswick to investment in processing facilities. The General Security model had a χ^2 of 34.4 with 31 degrees of freedom for $p = 0.3095$, while the Value Change Security model had a χ^2 of 32.2 with 31 degrees of freedom for $p = 0.4059$, suggesting that both models had considerably improved model fit compared to the initial models estimated.

Influences of tenure attributes on the endogenous variables were generally either of the expected sign or insignificant except for the influence of duration on investment in

[6] Recall from chapter 3 that modification indices are reported in the LISREL output and indicate the predicted drop in the chi-square statistic if a coefficient is added to the model and that a modification index greater than four indicates a coefficient that is expected to be statistically significant.

processing facilities, which was negative and significant[7]. Coefficients estimated in both models were generally consistent with those estimated in the initial model runs, with slight improvements in the significance of some coefficients indicating robustness of results. With the additional coefficients added to the models, the only modification index large enough to suggest addition of any other coefficients to the model was for export restrictions negatively influencing investment in silviculture (modification indices of approximately 7.3 in both models) which is discussed below in Section 5.1.4.

At this point in model development, the χ^2 test for overall model fit suggested that both models fit reasonably well (see χ^2 values listed above). However, the squared multiple correlations[8] were low for both General Security and Value Change Security (approximately 0.04 and 0.16 respectively), suggesting that additional variables were needed to explain variance in the two security variables. Although the perception variables previously discussed could be added to the models, variables would need to be removed before doing so because the number of estimates in the models was already close to the number of cases, with 105 estimates and 112 cases in each model. Furthermore, the use of the perceptions variables would further reduce the number of usable cases to 110 because of missing values. Therefore, to facilitate the addition of attribute perception variables to the models, both models were first re-estimated with the removal of the regional position variable and all provincial binary variables, except New Brunswick and Saskatchewan. These variables were removed because they were not causally influencing any of the endogenous variables in the model, but did require many estimates in the covariances of the exogenous variables. This re-estimation confirmed the robustness of results up to this point in that the remaining coefficient estimates were not

[7] The suspected cause of this unexpected negative influence is a lack of variability in the duration variable along with a few outliers that may be driving the negative coefficient. The majority of tenures in the sample have durations of 20 or 25 years with three Nova Scotia tenures having 50 year durations and one Newfoundland tenure having 99 year duration. Two methods of addressing this issue were attempted, the first of which was to remove the Nova Scotia and Newfoundland outliers. The second was to use the time until expiry for each tenure instead of duration, which would provide much more variability. Both of these attempts did not improve results of coefficients going from duration to the endogenous variables. In fact, with both methods the expected positive coefficients became less significant and the negative influence of duration on investment in processing facilities became more significant.

[8] Squared multiple correlations are the proportion of variation in a variable that is explained by the model and equals one minus the estimated error variance divided by the estimated total variance of the variable (Jöreskog and Sörbom 1996, p. 17)

significantly changed and there were no modification indices suggesting addition of new coefficients.

5.1.3 Adding perceptions of attributes to the models

Addition of all attribute assurance variables to the model increased the number of estimates in the model to 141. While it is noted that it is problematic to have that many more estimates than cases (110) in the model, the models were estimated in this way in order to see if any coefficients or variables could be removed, thus reducing the number of estimates. After the addition of attribute perceptions to the models, the General Security model had a χ^2 of 28.0, with 30 degrees of freedom for $p = 0.5698$, while the Value Change Security model had a χ^2 of 25.49 with 30 degrees of freedom for $p = 0.701$, suggesting a good fit for both models.

All coefficients for the effects of attribute assurances on tenure security were either of the expected sign or statistically insignificant. Modification indices from these two estimations indicated that duration assurance should directly influence incentives for investment in processing facilities with modification indices of 5.8 and 4.5 for the General Security and Value Change Security models respectively. Both models were then re-estimated with the addition of the coefficient for duration assurance influencing facility investment. The General Security model now had a χ^2 of 22.1 with 29 degrees of freedom for $p = 0.8169$, and the Value Change Security model had a χ^2 of 20.9 with 29 degrees of freedom for $p = 0.8645$. All coefficients for effects going from attribute assurances to the endogenous variables were of the expected positive sign, except for the influence of renewability assurance on tenure security which was negative and significant. Because the negative influence of renewability assurance on tenure security was not supported by theory or by the data[9], the renewability assurance variable was removed from the model. The attribute assurance variable for flexibility allowed in operational requirements was also removed since it had no significant impact on any of the three endogenous variables in either the General Security or Value Change Security

[9] The influence of renewability security was negative and significant despite a positive correlation and covariance between these two variables. Additionally, visual inspection of the data confirmed that most respondents answered the questions (2.1/2.3 & 2.20) so that one would expect a positive relationship

models. The final position variable (headquarters position) was also removed at this point because it was not directly influencing any of the endogenous variables in the model.

The models were re-estimated after the removal of the headquarters position variable and the attribute assurances for renewability and operational flexibility. This iteration of model estimations gave χ^2 of 11.69 and 15.62 for the General Security and Value Change Security models respectively, with 26 degrees of freedom in each model for $p = 0.97$ in the General Security model and $p = 0.945$ in the Value Change Security model. Most of the coefficients estimated in the models remained relatively unchanged, continuing to suggest robustness of results.

5.1.4 Testing the inter-relationship of export restrictions, Saskatchewan, Manitoba, incentives for investment

At this stage, the potential negative influence of export restrictions on incentives for investment in silviculture was tested. Because the modification indices for a strong negative influence of export restrictions on investment in silviculture only appeared after the addition of the influence from Saskatchewan to silvicultural investment, and because Saskatchewan and Manitoba are the only provinces that do not have export restrictions, it was suspected that the potential influence of export restrictions on silvicultural investment may be a function of the impacts of Manitoba and Saskatchewan more than the actual impacts of export restrictions themselves. To test this, the Manitoba binary variable was added to the model and all possible combinations of Manitoba, Saskatchewan and export restrictions were allowed to influence incentives for silvicultural investment in separate model runs. The results of this test suggest that the influence of export restrictions on incentives for investment in silviculture is highly dependent on the inclusion of Saskatchewan and Manitoba and the coefficient is unstable with values ranging from significantly negative to insignificant to significantly positive. As a result of this, export restrictions were removed from the model and Manitoba was added to the model with it influencing incentives for investment in silviculture.

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between the two variables (i.e. if they answered high security for 2.1 and 2.3 then they generally chose answers close to high security for 2.20).

Elimination of the coefficients and variables discussed above from the models reduced the number of estimates to 98, bringing it below the number of cases (110). The resulting final model is depicted in Figure 6. Readers are referred to Table 6 in Chapter 4 for descriptions of the variable names in Figure 6. The details of this final model specification will be discussed in the next section.

5.2 Model Results

5.2.1 Model diagnostics and general model fit

Table 7 displays some statistics on model fit included in the LISREL output for the General Security and Value Change Security models estimated using the specification displayed in Figure 6. The χ^2 values reported in Table 7 show a high probability that both the General Security model (0.9612) and the Value Change Security model (0.9431) imply covariance matrices that match the sample matrix. The removal of insignificant coefficients and variables that do not significantly impact any endogenous variables, and addition of modification index induced coefficients make those probabilities artificially high, making this statistic of model fit less indicative of actual model fit than if those variables and coefficients had not been added or removed. Earlier model runs, before variable and coefficient removals and additions had probabilities in the range of 0.6 to 0.7, still indicating good model fit.

Higher squared multiple correlations for tenure security in the Value Change Security model, suggests that the Value Change Security specification of tenure security is much better explained by the model than the General Security specification. However, in both models only a modest proportion of variance in all three endogenous variables is explained by the model, with the Value Change Security model explaining slightly more variance in all three endogenous variables than the General Security model.

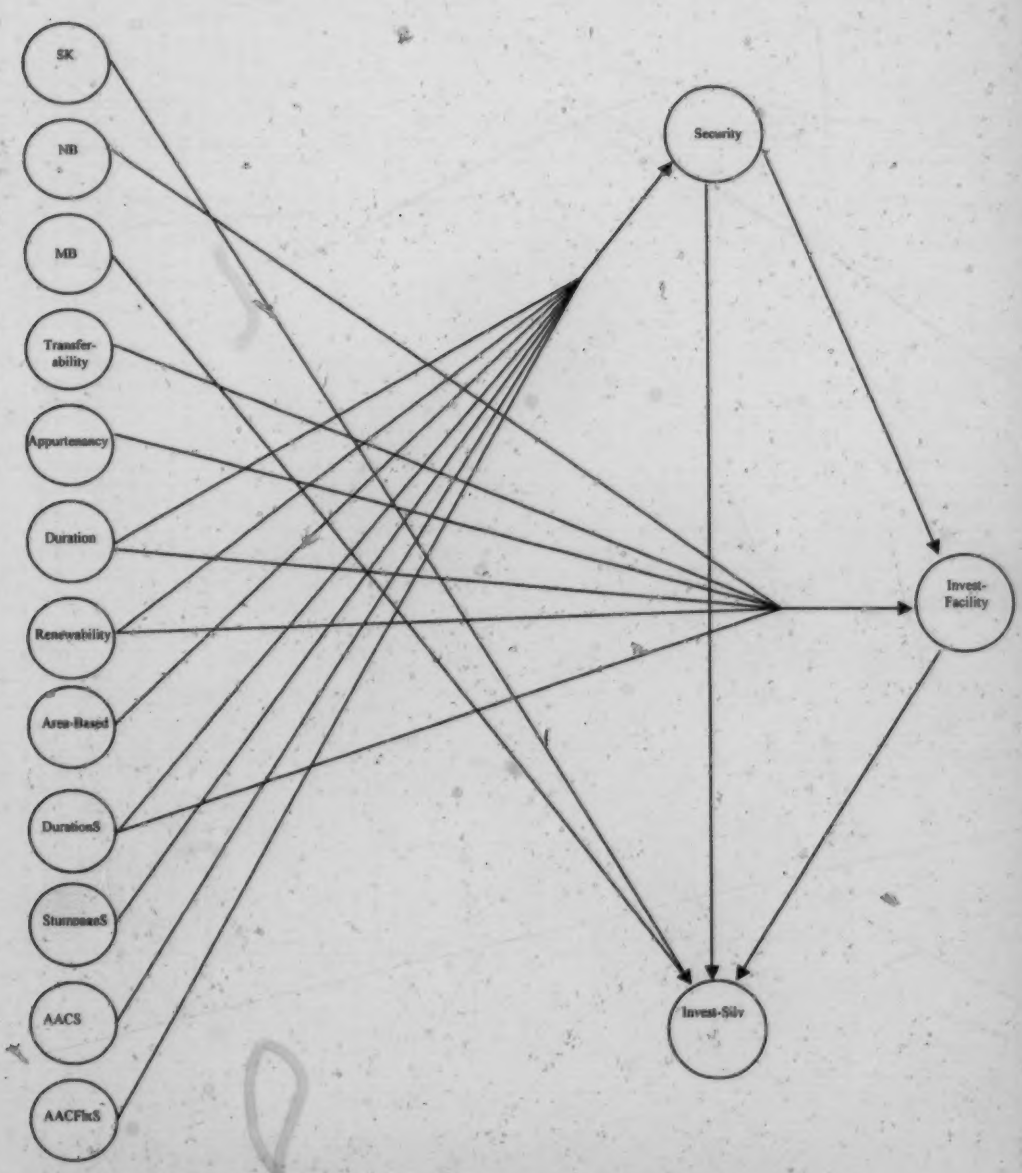

Figure 6. Final model diagram for combined actual values and perceptions model of Canadian forest tenures security and investment model.
Note: Variables ending in "S" (e.g. AACS) are attribute assurance variables.
Note: Indicators and covariances are not shown in this diagram.

Table7. Reported values for model fit statistics for the two Canadian forest tenures structural equation models (n = 100).

Diagnostic	General Security Model	Value Change Security Model
χ^2 (degrees of freedom)	11.8092 (22)	12.6249 (22)
Probability	0.9612	0.9431
Squared Multiple Correlation for Security	0.1598	0.3819
Squared Multiple Correlation for Investment-Processing	0.2105	0.2220
Squared Multiple Correlation for Investment-Silviculture	0.2544	0.2586

Other diagnostics reported in the LISREL output also indicated that there were generally no problems with the model estimations. For example, both models only required four iterations to converge and the iterations output generally showed good structure with no gaps where partial derivatives could not be calculated. LISREL did not provide any warnings after the four iterations. All standardized residuals had absolute value less than two, with most being close to zero. The largest absolute value in the standardized residuals in either model was 1.63, with a mean of zero for both models. The plot of residuals also suggested good models with linear grouping slightly steeper than the diagonal for both models. The largest modification indices in either model were approximately 3 for the removed influence from incentives for silvicultural investment to incentives for facility investment, with the next largest being 1.6, suggesting that no other coefficients should be added to the model. The correlation matrix for the parameter estimates suggested that there were no problems with colinearity since the largest absolute value in the matrices for both models was 0.8936, with only four correlations having an absolute value larger than 0.8 and only six having absolute value between 0.7 and 0.8. Altogether, these diagnostics suggest overall that the models fit well, with no obvious problems that need to be addressed.

5.2.2 Coefficient estimates

Table 8 displays the estimated parameters, along with standardized coefficient estimates for the General Security and Value Change Security models estimated based on

the specification in Figure 6. Figures 7 and 8 visually display the results for the General Security and Value Change Security models respectively. Note that influences found to be far from statistically significant ($p > 0.2$) were not included in the figures. Readers are once again referred to Table 6 in Chapter 4 for a description of the variable names used in Table 8, and Figures 7 and 8.

5.2.2.1 Tenure Security and Investment

As expected, the influence of security on incentives for investment in processing facilities is positive in both the General Security and Value Change Security models. However, the coefficient is only significant ($p < 0.15$) in the Value Change Security model. While, the influence of security on incentives for silvicultural investment is also positive as expected in both models, both coefficients are only significant at the 0.25 level. The influence of investment in processing facilities on silvicultural investment is positive and highly significant at the 0.01 level in both models.

The insignificant influence of tenure security on incentives for silvicultural investment was not entirely unexpected as it was expectated that investment in processing facilities would be the major driving factor behind silvicultural investment. The reasoning for this is that, as discussed in Chapter 2, previous studies have shown that Canadian forestry firms view silvicultural expenditures as costs of doing business rather than investments and therefore such expenditures could merely be driven by the need to supply timber to processing facilities and not by tenure security. The hypothesis that investment in facilities drives investment in silviculture is further supported by the highly significant positive influence of incentives for investment in processing facilities on incentives for silvicultural investment suggesting that silvicultural investment truly is driven at least partially by investments in timber processing facilities. The standardized coefficients of approximately 0.37 in both models for this influence are also the largest standardized effects in either model showing the relatively high importance of this effect. However, the squared multiple correlation for silvicultural investment is only approximately 0.25 in both models indicating that there are other factors not accounted for in the models that influence silvicultural investment.

Table 8. Estimates of the effects in two Canadian forest tenures structural equation models (n = 110).

Causal Influence		General Security Model		Value Change Security Model	
To variable	**From variable**	**Coefficient (β/Std.err)**	**Standardized Coefficient**	**Coefficient (β/Std.err)**	**Standardized Coefficient**
Invest-Facility	*Security*	0.0481 (0.5272)	0.0544	0.1450 (1.1514)*	0.1209
Investment-Silv	*Security*	0.0600 (0.6711)	0.0643	0.0859 (0.6933)	0.0679
Investment-Silv	*Invest-Facility*	0.3906 (3.8711)****	0.3704	0.3848 (3.7453)****	0.3646
Security	*Duration*	0.0252 (1.5695)**	0.1803	0.0108 (1.0326)*	0.1043
Security	*DurationS*	0.5197 (2.7222)****	0.3152	0.2078 (1.6779)***	0.1705
Security	*Renewability*	1.4346 (1.8254)***	0.205	1.6259 (3.1833)****	0.3144
Security	*Area-Based*	-0.3310 (-0.9589)	-0.1059	-0.8698 (-3.878)** †	-0.3766
Security	*StumpageS*	-0.0554 (-0.3342)	-0.0351	0.3572 (3.3129)****	0.3062
Security	*AACFlxS*	0.2868 (1.6572)***	0.1820	-0.0196 (-0.1740)	-0.0168
Security	*AACS*	-0.0793 (-0.5541)	-0.0648	0.1495 (1.6084)**	0.1653
Invest-Facility	*New Brunswick*	-1.3405 (-2.755)**** †	-0.2627	-1.3574 (-2.803)**** †	-0.2656
Invest-Facility	*Transferability*	0.4438 (1.6354)**	0.1687	0.4724 (1.7541)***	0.1793
Invest-Facility	*Appurtenancy*	0.3832 (1.4566)**	0.1488	0.4349 (1.6564)***	0.1686
Invest-Facility	*Duration*	-0.0251 (-2.1502)*** †	-0.2035	-0.0238 (-2.041)*** †	-0.1921
Invest-Facility	*DurationS*	0.3930 (2.5039)****	0.2694	0.3515 (2.2412)***	0.2406
Investment-Silv	*Saskatchewan*	-0.9915 (-1.8712)** †	-0.169	-0.9588 (-1.799)** †	-0.163
Investment-Silv	*Manitoba*	1.1712 (2.5870)**** †	0.234	1.2086 (2.667)**** †	0.2408

* Significant at the 0.20 level
** Significant at the 0.10 level
*** Significant at the 0.05 level
**** Significant at the 0.01 level
† Statistical significance is determined using a two-tailed t-test because the sign of the coefficient was either not predicted or incorrectly predicted. Statistical significance for all other coefficients not marked by † were calculated using a one-tailed test.

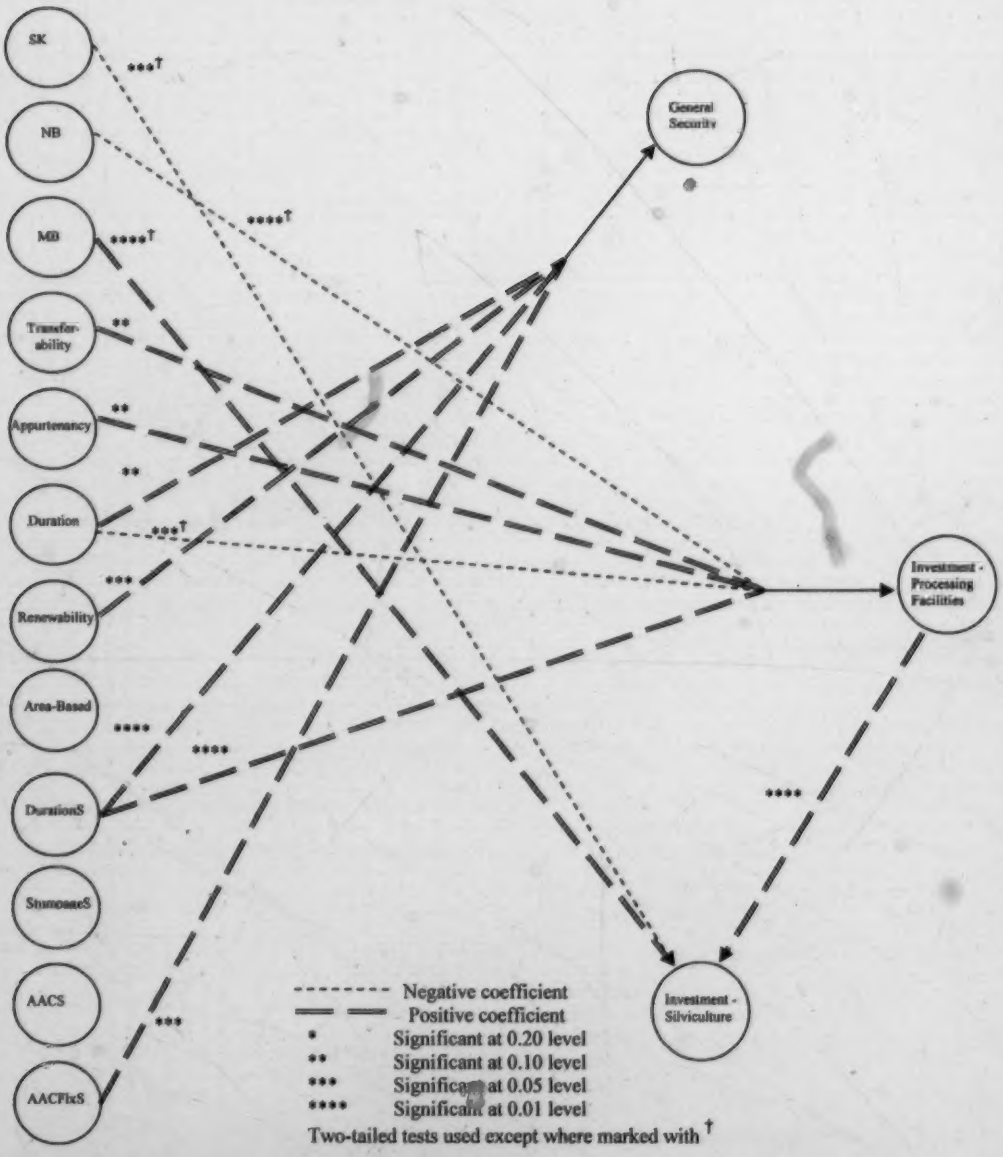

Figure 7. General Security Canadian forest tenures model diagram with signs and significance of estimated coefficients.

† Statistical significance is determined using a two-tailed t-test because the sign of the coefficient was either not predicted or incorrectly predicted. Statistical significance for all other coefficients not marked by † were calculated using a one-tailed test.

Note: Variables ending in "S" (e.g. AACS) are attribute specific security variables.

Note: Indicators and covariances are not shown in this diagram.

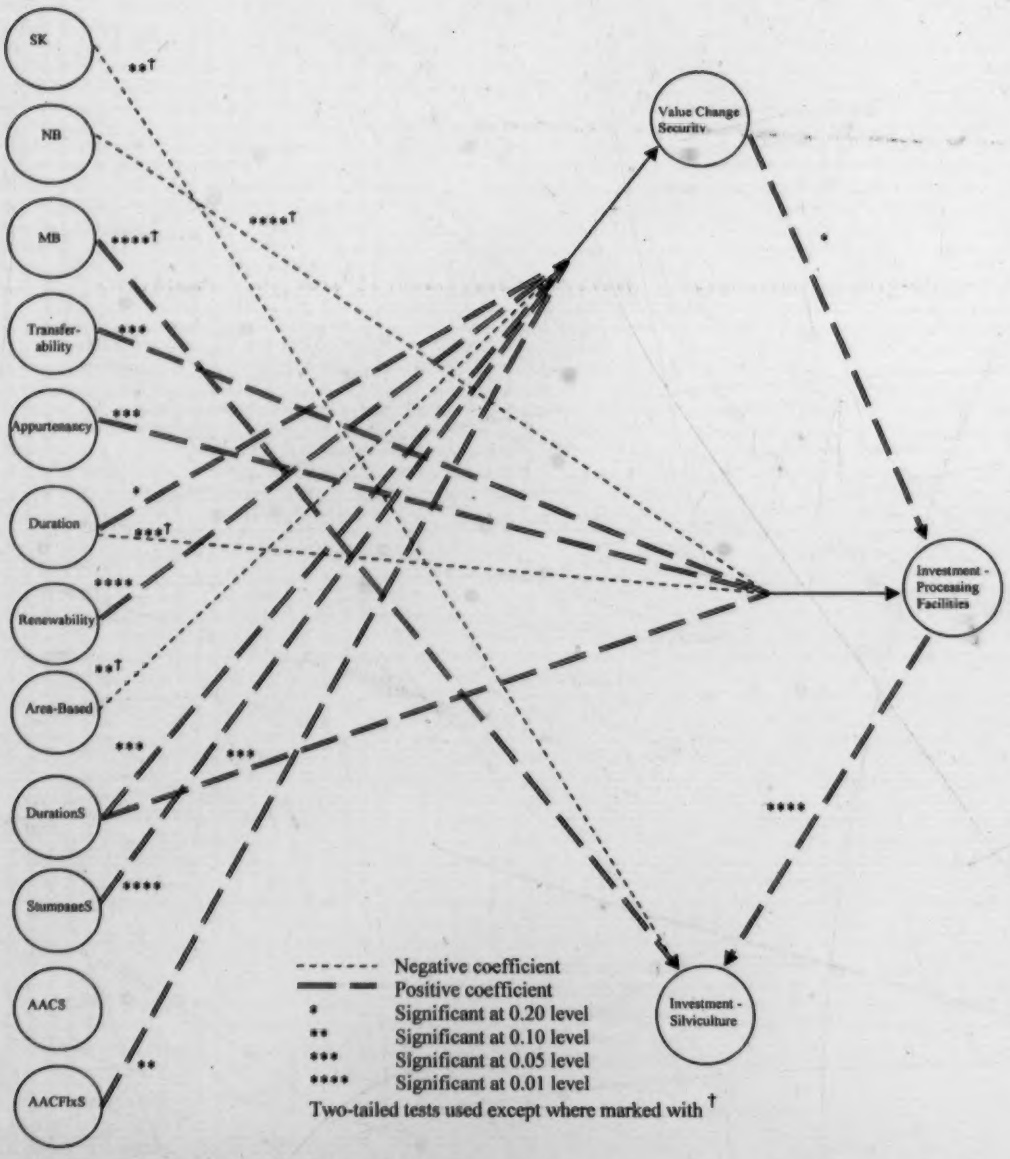

Figure 8. Value Change Security Canadian forest tenures model diagram with signs and significance of estimated coefficients.

† Statistical significance is determined using a two-tailed t-test because the sign of the coefficient was either not predicted or incorrectly predicted. Statistical significance for all other coefficients not marked by † were calculated using a one-tailed test.

Note: Variables ending in "S" (e.g. AACS) are attribute specific security variables.

Note: Indicators and covariances are not shown in this diagram.

Note: Coefficients far from significant ($p > 0.20$) are not displayed in this figure.

The positive influence of tenure security on investment in processing facilities was expected. The fact that this coefficient was insignificant in the General Security model, but significant in the Value Change Security model suggests that the expected impact of future changes to the tenure has a larger influence on firm's incentives to invest than the general concept of "security" as perceived by respondents[10]. The standardized coefficient for the influence of Value Change Security on facility investment also suggests that its influence is not as important as the influence of other variables such as renewability, area-based allotment and assurance of stumpage fees.

5.2.2.2 Influences of tenure attributes on tenure security

The influence of duration on tenure security was positive in both models, and significant at the 0.1 level in the General Security model, but only marginally significant ($p < 0.2$) in the Value Change Security model. Renewability had a significant positive influence on both General Security ($p < 0.05$) and Value Change Security ($p < 0.01$). Together these results support the hypothesis that longer termed, renewable tenures are likely more secure than shorter termed or non-renewable ones.

Area-based allotment type has a negative influence on tenure security in both models. However, the coefficient is insignificant in the General Security model, but significant at the 0.1[11] level in the Value Change Security model. The highly significant, negative influence of area-based allotment on the expected impact of future changes to the tenure was unexpected. While it was difficult to predict the sign of this coefficient, it was expectated that it would be positive based on the belief that firms which continually operate on the same land-base may be more secure in terms of government imposed changes to the firms' forest tenures. The reason for this belief was that since firms holding area-based tenures are responsible for managing the same land base for an extended period, government may be more reluctant to impose negative changes on such firms thus jeopardizing the management of those lands. However, the negative coefficient is potentially explainable by the possibility that holders of area-based tenures are

[10] Recall that General Security was based on respondents' answers to how secure they felt their tenure was, while Value Change Security was based on respondents' answers to how they felt the value of their tenure to their company would be impacted by changes made to the tenure.

generally larger firms and may view themselves as being a more visible target for environmental and social pressures that are applied to governments concerning forest management. This possible focus of environmental pressure on such firms may also be a product of area-based allotment because such pressure would then be focused on firms consistently managing the land base as opposed to firms operating on different lands each year. If this is the case, then such firms may feel less secure because they have increased expectations of restrictions being placed on their operations as a result of public and/or environmental group pressure.

Each attribute assurance variable had a significant positive influence on tenure security in at least one of the two models. However, duration assurance was the only attribute assurance that was significant in both the General Security ($p < 0.01$) and Value Change Security ($p < 0.05$) models. The assurance of stumpage fees was insignificant in the General Security model, but positive and highly significant at the 0.01 level in the Value Change Security model. Assurance of the amount of flexibility allowed around the AAC was positive and significant at the 0.05 level in the General Security model, but insignificant in the Value Change Security model. Assurance of AAC levels had almost the exact opposite impacts as security in AAC flexibility, with an insignificant impact in the General Security model, but a positive influence in the Value Change Security model ($p < 0.1$). These results support the hypotheses that attribute assurance variables would either positively influence tenure security or be unimportant and therefore statistically insignificant.

Based on the standardized coefficients displayed in Table 8, the most important influences on General Security were duration assurance with a standardized coefficient of 0.315 followed by renewability and duration with standardized coefficients of 0.205 and 0.18 respectively. Value Change Security was most strongly influenced by area-based allotment with a standardized coefficient of -0.3766 followed by renewability and stumpage assurance with standardized coefficients of 0.314 and 0.306 respectively.

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[11] A two-tailed t-test was used for this coefficient because its sign was not predicted.

5.2.2.3 Influences of tenure security and tenure attributes on perceived incentives for investment in timber processing facilities

Transferability and appurtenancy both have the expected positive, statistically significant influence on incentives for investment in timber processing facilities (both coefficients were significant at the 0.1 level in the General Security model and the 0.05 level in the Value Change Security model). New Brunswick had a highly significant ($p < 0.01$) negative influence on investment in processing facilities in both models. One potential reason for this unexpected effect is that it could be a consequence of having observed only six responses from that province. A second possible explanation is that firms in New Brunswick really do perceive worse incentives for investment in processing facilities. Unfortunately, information on new investments in the forestry sector has been "unavailable" for New Brunswick in the six most recent State of Canada's Forests reports, so these reports cannot be used to investigate this result further (NRCAN 2000 thru 2006). This result may be explained by recent occurrences in New Brunswick forest policy. For example, in 2003 overall wood supply in the province was reduced in order to increase protected areas (Ashton and Anderson 2005). The forest industry in New Brunswick also recently lost a political battle to increase AAC levels. This debate resulted from a report prepared by Jaakko Pöyry Management Consulting which suggested that AAC levels in New Brunswick could be doubled by within 50 years if more intensive silvicultural activities are carried out (Ashton and Anderson 2005). It is believed that the financial industry was seeking such assurances of a secure wood supply before financing further investments in forestry operations (Ashton and Anderson 2005).

The assurance variable for duration of tenure had a somewhat unexpected positive and highly significant impact on investment in processing facilities ($p < 0.01$ and $p < 0.05$ in the General Security and Value Change Security models respectively). As discussed in the previous chapter, it was doubtful that attribute assurance variables would significantly influence the investment variables because the investment variables represent current incentives while the attribute assurances represent expected future changes. However, if respondents considered future expectations when answering the questions on incentives for investment, then it would be possible for attribute assurance variables to influence the investment variables. If this occurred,

then it would be expected that any influences be positive as is found with the influence of duration assurance on investment in processing facilities. This result suggests that expected changes to the duration of a tenure that increase its value to the company increased perceived incentives for investment in processing facilities.

An unexpected result was the negative influence of duration on incentives for investment in processing facilities, which was statistically significant at the 0.05 level in both models. It was expected that longer duration tenures would have a positive influence on incentives for investment unless duration is unimportant in which case the influence would be statistically insignificant. A potential explanation for this result is based on the provinces that created most of the variation in the duration variable. Other than one Newfoundland response with a duration of 99 years, one Ontario FRL with 5 year duration, and three Nova Scotia responses with 50 year durations, all other responses have duration of either 20 or 25 years. Of these responses, the tenures with 25 year durations occured in British Columbia, New Brunswick and Quebec. As mentioned above, we have already seen that New Brunswick respondents perceived poor incentives for facility investment possibly due to recent forest policy occurences. It should also be noted that British Columbia and Quebec are provinces in which there have been considerable changes to forest policy and tenure arrangements. In British Columbia, the Forest Practices Code (discussed in Chapter 1) has had significant impacts on the forest industry. In Quebec, the provincial government has accepted the recommendations of the Coulombe Commission calling for an overhaul of forest management in the Province and a 20% reduction in wood harvests (Moore 2005). These issues in British Columbia, New Brunswick and Quebec, coupled with the fact that these provinces form the main group of "longer" tenures could lead to the negative influence of duration on incentives for investment in timber processing facilities.

The most important influences on incentives for investment in processing facilities were duration assurance with standardized coefficients of 0.269 and 0.2406 in the General Security and Value Change Security models respectively, and New Brunswick with standardized coefficients of approximately -0.26 in both models. Duration also had a large influence on facility investment with a standardized coefficient of approximately -0.2 in both models.

5.2.2.4 Influences of tenure security and tenure attributes on perceived incentives for investment in silviculture

The only exogenous variables to have statistically significant impacts on incentives for investment in silviculture were the Manitoba and Saskatchewan binary variables. There are two possible explanations for the negative influence of Saskatchewan on investment in silviculture. The first is that this may simply be a product of the sampling. That is, with only five responses from Saskatchewan in the sample it is possible that a disproportionately high number of those five believed that their tenures had poor incentives for silvicultural investment. However, it is also possible that this result is indicative of Saskatchewan tenures truly having poor incentives for silviculture relative to other provinces. This is supported by reported percentages of Crown forest land that are understocked in the annual State of Canada's Forests reports. In the 2000-01 and 2001-02 reports, Saskatchewan had 64% understocked Crown forest lands compared to national averages of 12% and 14% respectively (NRCAN 2001; 2002). In both reports, the next highest provincial level was Alberta with 33% understocked in both years. In the two subsequent State of Canada's Forests reports, understocked percentages were not available for Saskatchewan and the statistic was not reported in the two most recent reports (NRCAN 2003; 2004; 2005; 2006). This information could be seen as a possible explanation for a respondent representing a Saskatchewan company perceiving poor incentives for silvicultural investment.

The positive, significant impact of Manitoba on incentives for investment in silviculture is also supported by the State of Canada' Forests reports. In the 2002-03 and 2003-04 reports, Manitoba's Crown land was only 5% understocked compared to national averages of 13% in both years. The only provinces with lower percentages of understocked Crown land were Quebec (3% and 4%) and Nova Scotia (3% in both years). (NRCAN 2003; 2004). Based on these numbers, it is not surprising that respondents in Manitoba perceived better incentives for silvicultural investments than respondents from other provinces. However, it should be noted that the positive influence of Manitoba on silvicultural investment could also be a result of sampling with only seven responses coming from that province.

The fact that no other variables have statistically significant impacts on incentives for silvicultural investment was expected. Based on the hypothesis that silvicultural expenditures

are viewed more as costs of business than as investments, it was expected that the major influence on silvicultural investment would be investment in timber processing facilities. Therefore one would expect that silvicultural investment would not be influenced by most other tenure attributes. That is, investments in silviculture would be largely unaffected by the form of tenure, but instead be mainly dependent on investments in timber processing facilities.

5.2.3 Substance and assurance of rights in Canadian forest tenures

Of the two tenure security variables, Value Change Security (the expected impact of future changes to a tenure) appears to better reflect the assurance of property rights conveyed by forest tenures than does General Security (perceived "security" of the tenure). The assertion that Value Change Security is a better measure of assurance of forest tenures than General Security is supported by the fact that Value Change Security is influenced by more of the included variables and has stronger influences on the two investment incentive variables. Value Change Security is influenced by duration, renewability, allotment type, duration assurance, assurance of stumpage fees and AAC assurance. In contrast, General Security was only influenced by duration, renewability, duration assurance, and assurance of AAC flexibility. Value Change Security was also found to have a stronger influence on both investment incentive variables than General Security had. This is also supported by examination of the standardized coefficients which shows that Value Change Security had three variables influencing it with absolute values of standardized coefficients greater than 0.3 and three more with absolute values greater than 0.1. General Security only had one influencing variable with an absolute value greater than 0.3, one greater than 0.2 and three greater than 0.1.

The models were re-estimated to test the possibility that the removal or isolation of tenure security might cause more of the attribute assurances to influence the investment variables and/or strengthen existing influences of attribute assurances on investment. This was carried out by removing all influences to and from tenure security but retaining the tenure security variables in one set of models, and in a separate model by completely removing the tenure security variables. In both cases, no additional significant influences from attribute assurances occurred and no existing influences became more significant. Additionally, both new model specifications had

considerably worse model fit ($p = 0.005$ and $p = 0.002$ for the models with security "isolated" and removed respectively) than the models discussed so far in this thesis. This test reinforces the idea that a variable indicating overall assurance for the tenure is an important explanatory variable in models of forestry firm behavior.

The model results discussed above in section 4.2.2 support the hypotheses that both the assurance of rights and the substance of those rights will influence incentives for behavior and that substance will also affect assurance. The hypothesis that the assurance of rights influences perceived behavior is supported by the impact of Value Change security on incentives for investment in processing facilities and the influences of duration assurance on incentives for investment in processing facilities in both models. While the influence of Value Change Security did not have a highly significant ($p < 0.15$) impact on incentives for facility investment, and the standardized coefficient was smaller than some other influences on facility investment, the results do clearly indicate that in the case of Canadian forest tenures, the assurance of a tenure's rights do indeed have impacts on perceived behavior that are separate from the impacts of the substance of those rights. This, along with the test in the previous paragraph in which security was removed from the models suggests that it would be ideal to include some measure of a forest tenure's assurance in any thorough analysis of Canadian forestry firms' behavior.

The hypothesis that the substance of rights will influence the assurance of those rights is supported by the effects from duration (both models), renewability (both models) and allotment type (Value Change Security model only) to tenure security. The hypothesis that the substance of rights will influence perceived behavior is supported by the effects from transferability, appurtenancy, and duration to incentives for investment in processing facilities in both models.

6. Summary and Conclusions

Several gaps or problems were identified in the literature review on Canadian forest tenures and tenure security in general. These include a lack of studies examining the influence of multiple forest tenure attributes on the behavior of Canadian forestry firms on a nation-wide basis, including linking security of individual forest tenures to those attributes and behavior. In the general literature on tenure security, empirical results may have been inconsistent, partially because of a divergence in ways of measuring security, and because of a lack of modeling security and investment endogenously. Measures of security generally have fallen into two categories: measures of the assurance of rights and measures of the substance of rights.

This thesis attempted to address the above issues by empirically analyzing data from a nation-wide survey of forest tenure holders in Canada. These data were analyzed in structural equation models that examine the influence of multiple tenure attributes on respondents' perceived tenure security, and the influence of those attributes and security on respondents' perceived incentives for investment. Tenure security was measured in two ways: 1) by asking how secure respondents perceived their tenure to be (General Security), and 2) by asking how respondents believe the value of the tenure to their company would change as a result of changes to the tenure (Value Change Security). Thus, security was measured as assurance of the rights that the forest tenure entails and was measured on an individual basis, allowing estimation of the effects of both the assurance and substance of property rights in Canadian forest tenures. Additionally, potential endogeneity of tenure security and perceived incentives for investment was accounted for in empirical analyses.

6.1 Assurance versus substance of rights

Results from empirical analysis of nation-wide data on Canadian forest tenures indicate that perceived behavior of Canadian forestry firms, measured as perceived incentives for investment, is influenced by both the assurance and substance of forest tenures, and that the assurance of tenures is influenced by their substance.

The results of the two Canadian forest tenures models suggest that both assurance and substance of rights influence perceived incentives for investment by forestry firms in Canada.

Value Change Security was found to positively influence perceived incentives for investment in timber processing facilities. Neither specification of tenure security was found to have a significant direct effect on perceived incentives for investment in silviculture. Additionally, the assurance tenure duration also had a strong positive influence on incentives for investment in timber processing facilities. The substance of forest tenures was also found to influence perceived incentives for investment in such facilities in that transferability, appurtenancy and duration were all found to significantly influence facility investment.

In contrast to incentives for facility investment, silvicultural investment incentives were not influenced by the substance or assurance of tenures. Silvicultural investment incentives were found to be influenced by facility investment, with other influences coming only from the provincial variables for Manitoba and Saskatchewan. These results support the conclusions of previous studies that woodlands are seen as cost centres for processing plants and that silvicultural expenditures are largely driven by investment in timber processing facilities, while not being directly influenced by either the substance or assurance of forest tenures.

The results also suggest that the assurance of forest tenures is influenced by the tenure's substance. The relatively strong influences of duration and renewability of tenure on security suggest that it may be acceptable to use substance measures for security. Given the demonstration of separate impacts of assurance and substance on perceived behavior, it would be ideal to have measures of both the substance and assurance of rights in future empirical analyses. Inclusion of only substance or only assurance aspects of tenures in empirical analysis could lead to an incomplete explanation of firm behavior.

6.2 Policy recommendations

Model results suggest several potential options for provincial governments wishing to increase security of tenure and/or investment incentives for Canadian forestry firms. Increasing the probability of tenure renewal, reducing stumpage fees, increasing AACs and increasing flexibility allowed around AACs all have the potential to increase assurance of forest tenures which should in turn should increase incentives to invest in timber processing facilities.

Potential options for directly increasing facility investment are removing restrictions or impediments to the sale of tenures and reducing the perceived likelihood that tenures' durations will be reduced. Given the potential negative influence of duration on facility investment and the potential positive influence of duration on tenure security, it is difficult to predict the impact of changes to tenure durations. Consideration of these factors could provide potential avenues of exploration for ways to halt the steady stream of mill closures and job losses across the nation in recent years.

To increase incentives for investment in silviculture, governments could look to increase incentives for investing in mills or alternatively look for ways to make firms view silviculture expenditures as investments rather than as costs of feeding their mills, thus potentially separating incentives for silvicultural investment from mill investment. Successfully separating silvicultural expenditures from mill investment could lead to firms treating such expenditures as investments in future forests. Such a change could provide incentives for firms to develop new and innovative ways to grow trees and sustain forests in Canada, reducing the need for costly government regulation and potentially providing an important step towards achieving sustainable forest management.

6.3 Limitations and further research

One concern with this study is the small sample size (n = 110) of respondents. Given the complexity of the models analyzed, and the potential for considerably higher complexity with the addition of other desirable variables, a larger sample would provide much more statistical reliability. Having said that, the results discussed here were generally robust in that coefficients were quite stable as models were re-estimated over the course of their development.

Future research of this type should consider possible methods to increase the number of respondents. One example of how this could be done would be to conduct face-to-face interviews rather than relying on telephone recruitment for an online survey. Such in-person interviews could also provide the opportunity to obtain additional information that could potentially provide significant insight into the discussion of Canadian forest tenures and firm behavior.

Obtaining data on other actual values of tenure attributes such as amounts of stumpage fees paid, harvest levels and annual allowable cut levels could also provide valuable insights into the determinants of Canadian forestry firm behavior. Additionally, obtaining data on actual investment amounts would also provide a clearer picture of firm behavior than relying on perceived incentives for investment provides. Being able to model actual investments instead of incentives for investment would also provide the opportunity to further clarify the inter-relationship of tenure security and investment. Although this study has provided insights into the influence of tenure security and other tenure attributes on perceived firm behavior and the influence of tenure attributes on tenure security, the addition of some of the information listed above could significantly improve our understanding of how the specification of forest tenures impacts the assurance of forest tenures and the behavior of Canadian forestry firms.

References

Adamowicz, W.L. and T.S. Veeman. 1998. Forest Policy and the Environment: Changing Paradigms. *Canadian Public Policy* 24S: S51-S61.

Alavalapti, J.R.R. and M.K. Luckert. 1997. Modeling the effect of institutional constraints on short-run timber supply on public land: A case study of Quota holders in Alberta. *Natural Resource Modeling* 10(4): 263-282.

Angelsen, A. 2007. Forest cover change in space and time: Combining the von Thünen and forest transition theories. World Bank Policy Research Working Paper 4117, February 2007.

Ashton, W. and B. Anderson. 2005. New Brunswick's "Jaakko Pöyry" report: perceptions of senior forestry officials about its influence on forest policy. *The Forestry Chronicle* 81(1): 81-87.

Benin, S., M. Ahmed, J. Pender and S. Ehui. Development of land rental markets and agricultural productivity growth: the case of Northern Ethiopia. *Journal of African Economies* 14(1): 21-54.

Besley, T. 1995. Property rights and investment incentives: theory and evidence from Ghana. *The Journal of Political Economy* 103(5): 903-937.

Brasselle, A., F. Gaspart and J. Platteau. 2002. Land tenure security and investment incentives: puzzling evidence from Burkina Faso. *Journal of Development Economics* 67: 373-418.

Burton, P.J., C. Messier, G.F. Weetman, E.E. Prepas, W.L. Adamowicz and R. Tittler. 2003. The Current State of Boreal Forestry and the Drive for Change. *In* Towards Sustainable Management of the Boreal Forest. NRC Research Press, Ottawa, ON.

Cattaneo, A. 2001. Deforestation in the Brazilian Amazon: comparing the impacts of macroeconomic shocks, land tenure, and technological change. *Land Economics* 77(2): 219-240.

Cumming, S.G. and G.W. Armstrong. 2001. Divide landbase and overlapping forest tenure in Alberta, Canada: A simulation study exploring costs of forest policy. *Forestry Chronicle* 77(3): 501-508.

Cumming, S.G. and G.W. Armstrong. 2004. Divide landbase, overlapping tenures and fire risk. *Forestry Chronicle* 80(4): 478-484.

Deacon, R.T. 1994. Deforestation and the rule of law in a cross-section of countries. *Land Economics* 70(4): 414-430.

Deacon, R.T. 1999. Deforestation and ownership: evidence from historical accounts and contemporary data. *Land Economics* 75(3): 341-359.

Feder, G., J.L. Lawrence, J.Y. Lin and X. Luo. 1992. The Determinants of farm investment and residential construction in post-reform China. *Economic Development and Cultural Change* 41(1): 1-26.

Feder, G. and T. Onchan. 1987. Land ownership security and farm investment in Thailan. *American Journal of Agricultural Economics* 69(2): 311-320.

Feder, G., T. Onchan and Y. Chalamwong. 1988. Land policies and farm performance in Thailand's Forest Reserve Areas. *Economic Development and Cultural Change* 36(3): 483-501.

Gavian, S. and M. Fafchamps. 1996. Land tenure and allocative efficiency in Niger. *American Journal of Agricultural Economics* 78(2): 460-471.

Globerman, S., M. Nakamura, K. Ruckman and I. Vertinsky. 1998. Innovation, Strategy and Canada's Forest Products Industry. *Canadian Public Policy* 24S: S27-S40.

Godoy, R., M. Jacobson, J. De Castro, V. Aliaga, J. Romero and A. Davis. 1998. The role of tenure security and private time preference in neotropical deforestation. *Land Economics* 74(2): 162-170.

Godoy, R., K. Kirby and D. Wilkie. 2001. Tenure security, private time preference, and use of natural resources among lowland Bolivian Amerindians. *Ecological Economics* 38: 105-118.

Grafton, R.Q., R.W. Lynch and H.W. Nelson. 1998. British Columbia's Stumpage System: Economic and Trade policy Implications. *Canadian Public policy* 24S: S41-S50.

Haley, D. and M.K. Luckert. 1990. Forest Tenures in Canada: A Framework for Policy Analysis. Forestry Canada Information Report E-X-43. Ottawa: Supply and Services Canada.

Haley, D. and M.K. Luckert. 1998. Tenures as Economic Instruments for Achieving Objectives of Public Forest Policy in British Columbia. In The Wealth of Forests. Vancouver, BC: UBC Press.

Hawkins, C.B.D., T.W. Steele and T. Letchford. 2006. The economics of site preparation and the impacts of current forest policy: evidence from central British Columbia. *Canadian Journal of Forest Research* 36: 482-494.

Hailu, G., P.C. Boxall and B.L. McFarlane. 2005. The Influence of place attachment on recreational demand. *Journal of Economic Psychology* 26(4): 581-598.

Hayes, J., M. Roth and L. Zepeda. 1997. Tenure security, investment and productivity in Gambian agriculture: A generalized probit analysis. *American Journal of Agricultural Economics* 79: 369-382.

Hegan, R.L. and M.K. Luckert. 2000. An economic assessment of using the allowable cut effect for enhanced forest management policies: an Alberta case study. *Canadian Journal of Forest Research* 30(10): 1591-1600.

Holden, S. and H. Yohannes. 2002. Land redistribution, tenure insecurity, and intensity of production: a study of farm households in Southern Ethiopia. *Land Economics* 78(4): 573-590.

Jöreskog, K and D. Sörbom, 1996. LISREL 8: User's reference guide. Lincolnwood, Il: Scientific Software International Inc.

Li, G., S. Rozelle and L. Brandt. 1998. Tenure, land rights, and farmer investment incentives in China. *Agricultural Economics* 19(1): 63-71.

Luckert, M.K. 1988. The effect of some British Columbia forest tenures on the distribution of rents, the allocation of resources, and investments in silviculture. Ph.D. thesis, Faculty of Forestry, University of British Columbia, Vancouver.

Luckert, M.K. 1991a. The perceived security of institutional investment environments of some British Columbia forest tenures. *Canadian Journal of Forest Research* 21: 318-325.

Luckert, M.K. 1991b. Effect of Canadian Forest Tenures on Rent Distributions and Resource Allocations: A British Columbia Case Study. *Forest Science* 37(5): 1441-1462.

Luckert, M.K. 1993. Property rights for changing forest values: A study of mixed wood management in Canada. *Canadian Journal of Forest Research* 23(4): 688-699.

Luckert, M.K. 1997. Towards a Tenure Policy Framework for Sustainable Forest Management in Canada. *The Forestry Chronicle* 73(2): 211-215.

Luckert, M.K. 1998. Efficiency implications of silvicultural expenditures from separating ownership and management on forest lands. *Forest Science* 44(3): 365-378.

Luckert, M.K. and D. Haley. 1990. The implications of various silvilcultural funding arrangements for privately managed public forest land in Canada. *New Forest* 4: 1-12.

Luckert, M.K. and D. Haley. 1993. Canadian forest tenures and the silvicultural investment behavior of rational firms. *Canadian Journal of Forest Research* 23: 1060-1064.

Luckert, M.K. and D. Haley. 1995. The Allowable Cut Effect (ACE) as a policy instrument in Canadian forestry. *Canadian Journal of Forest Research* 25: 1821-1829.

Luckert, M.K. and F.J. Salkie. 1998. Forestry in Canada: Transition and Emerging policy Issues. *Canadian Public* 24S: S1-S10.

Mendelsohn, R. 1994. Property rights and tropical deforestation. *Oxford Economic Papers* 46: 750-756.

Moore, L. "Quebec braces for forestry shock: :[Final Edition]." *The Gazette*, May 7, 2005, http://www.proquest.com/ (accessed September 24, 2007).

Nanang, D.M. and G.K. Hauer. 2006. Estimating the costs of overlapping tenure constraints: a case study in Northern Alberta, Canada. *Forest Policy and Economics* 8: 610-624.

Nautiyal, J.C. and J.K. Rawat. 1986. Role of forest tenure in the investment behaviour of integrated Canadian forestry firms. *Canadian Journal of Forest Research* 16: 456-463.

Nelson, H., I.B. Vertinsky, M.K. Luckert, M. Ross and B. Wilson. Designing Institutions for Sustainable Forest Management. *Towards Sustainable Management of the Boreal Forest.* NRC Research Press, Ottawa, ON. Pp. 213-259.

NRCAN. 2001. The State of Canada's Forests 2000-2001. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

NRCAN. 2002. The State of Canada's Forests 2001-2002. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

NRCAN. 2003. The State of Canada's Forests 2002-2003. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

NRCAN. 2004. The State of Canada's Forests 2003-2004. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

NRCAN. 2005. The State of Canada's Forests 2004-2005. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

NRCAN. 2006. The State of Canada's Forests 2005-2006. Natural Resources Canada. Available at: http://cfs.nrcan.gc.ca/sof/previous_e.html

Otsuka, K., S. Suyanto, T. Sonobe and T.P. Tomich. 2001. Evolution of land tenure institutions and development of agroforestry: evidence from customary land areas of Sumatra. *Agricultural Economics* 25: 85-101.

Owubah, C.E., D.C. Le Master, J.M. Bowker and J.G. Lee. 2001. Forest tenure systems and sustainable forest management: the case of Ghana. *Forest Ecology and Management* 149: 253-264.

Pearse, P.H. 1998. Economic Instruments for Promoting Sustainable Forestry: Opportunities and Constraints. In The Wealth of Forests. Vancouver, BC: UBC Press.

Place, F. and P. Hazell. 1993. Productivity effects of indigenous land tenure systems in Sub-Saharan Africa. *American Journal of Agricultural Economics* 75(1): 10-19.

Place, F. and K. Otsuka. 2000. Population pressure, land tenure, and tree resource management in Uganda. *Land Economics* 76(2): 233-251.

Place, F. and K. Otsuka. 2001. Population, tenure and natural resource management: the case of Customary Land Area in Malawi. *Journal of Environmental Economics and Management* 41: 13-32.

Place, F. and K. Otsuka. 2002. Land tenure systems and their impacts on agricultural investments and productivity in Uganda. *The Journal of Development Studies* 38(6): 105-128.

Razzaz, O.M. 1993. Examining property rights and investment in informal settlements: the case of Jordan. *Land Economics* 69(4): 341-355.

Robinson, E.J. 2005. Reassessing the interaction between investment and tenure uncertainty. *Environment and Development Economics* 10: 143-157.

Sjaastad, E. and D.W. Bromley. 1997. Indigenous land rights in Sub-Saharan Africa: Appropriation, security and investment demand. *World Development* 25(4): 549-562.

Sjaastad, E. and D.W. Bromley. 2000. The prejudices of property rights: on individualism, specificity, and security in property rights. *Development Policy Review* 18: 365-389.

Smith, R.E. 2004. Land tenure, fixed investment, and farm productivity; evidence from Zambia's southern province. *World Development* 32(10): 1641-1661.

Southgate, D., R. Sierra and L. Brown. The causes of tropical deforestation in Ecuador: a statistical analysis. *World Development* 19(9): 1145-1151.

Van Kooten, G.C. and S. Wang. 1998. Estimating Economic Costs of Nature Protection: British Columbia's Forest Regulations. *Canadian Public Policy* 24S: S63-S71.

Wang, S., G.C. van Kooten, and B. Wilson. 2003. Silvicultural practices and costs in coastal British Columbia: a case study. *Tree Planters' Notes* 50(1): 50-57.

Zhang, D. 1996. Forest tenures and land value in BC. *Journal of Forest Economics* 2: 7-30.

Zhang, D. and P.H. Pearse. 1996. Differences in silvicultural investment under various types of forest tenure in British Columbia. *Forest Science* 442-449.

Zhang, D. and P.H. Pearse. 1997. The influence of the form of tenure on reforestation in British Columbia. *Forest Ecology and Management* 98: 239-250.

Appendix A – Survey Sample

This survey is designed to elicit opinions and preferences on how well the agreements made between forest industry firms and provincial governments are working. These agreements are referred to as forest tenures, which define the rights and obligations of private companies harvesting timber on Crown lands. We are interested in the conditions of these agreements that regulate the industrial use of forest resources on Crown lands.

1. Which of the following best describes your position in your company? Please check only one.

- ☐ You work in a headquarters office that is primarily involved in central planning
- ☐ You work in a regional office that is primarily involved in operational planning
- ☐ Neither of the above.

Section 1

In this section, we focus on several conditions of forest tenures that will be referred to as tenure characteristics. These are:

- **The duration of the tenure**: how long private firms may harvest timber and/or other forest resources before renewal is necessary.
- **Stumpage fees**: the amounts that private firms are required to pay to the province in return for harvesting timber.
- **Flexibility of operational requirements**: the degree to which requirements concerning utilization of wood in harvesting; measures to protect the forest environment; reforestation and other forestry operations are prescribed. Highly prescribed requirements do not allow the firm much flexibility in carrying out forestry operations compared to less prescribed requirements.
- **Flexibility of timber harvest levels**: the amount that private firms are allowed to deviate from projected annual allowable cuts
- **Wood processing requirements**: the proportion of wood that a company harvests that must be processed in plants owned or operated by the tenure holder.

Each of these tenure characteristics has the potential to influence how well forestry operations meet or align with the various benefits that Canadians desire from their forests. In the questions that follow, we ask for your thoughts on how changes in current tenure characteristics may, or may not, be important in influencing the following social objectives from forests: competitiveness, promoting or maintaining the environmental integrity of forests, and promoting or maintaining community stability.

Competitiveness

Competitiveness refers to the ability of Canadian forest companies to compete in global markets. Increased competitiveness would lead to an expanding forestry sector, thereby leading to more jobs and/or capital investments.

Below are profiles made up of various combinations of tenure characteristics. In this section please think of tenure agreements in terms of their implications for the competitiveness of the forest industry. Then, choose **one Best and one Worst** characteristic for maintaining or enhancing competitiveness.

Question 1a: Suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **competitiveness**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is increased by 10 years.	☐
☐	Stumpage fees remain at current levels	☐
☐	Operational requirements for tenure holders remain as currently prescribed.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC remains at the current level.	☐
☐	None of the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 1a.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing competitiveness?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 1b: Now, suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **competitiveness**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is maintained.	☐
☐	Stumpage fees are increased to twice current levels.	☐
☐	Operational requirements for tenure holders become more prescribed so that firms have less discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is half current levels.	☐
☐	All the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 1b.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing competitiveness?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 1c: Now, suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **competitiveness**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is reduced by 10 years.	☐
☐	Stumpage fees remain at current levels.	☐
☐	Operational requirements for tenure holders become less prescribed so that firms have more discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is twice of current level.	☐
☐	Some proportion of the wood (e.g. 50% or 75%) harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 1c.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing competitiveness?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Environmental integrity of forest

Environmental integrity of forests is a broad concept that includes multiple factors associated with forest resources. Maintaining and/or increasing environmental integrity would support enhanced biodiversity, wildlife populations, and forest recreation. Moreover, increasing integrity of the forest environment may help sustain the benefits associated with harvesting non-timber forest products (e.g. berries, mushrooms, etc.).

Now, please think of tenure agreements in terms of environmental integrity of forests. Choose **one Best and one Worst** factor that can maintain or enhance environmental integrity of forests.

Question 2a: Suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **environmental integrity**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	**Worst** characteristic (Please check only one)
☐	Current duration of tenure is reduced by 10 years.	☐
☐	Stumpage fees are increased to twice current levels.	☐
☐	Operational requirements for tenure holders remain as currently prescribed.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is twice current levels.	☐
☐	Some proportion of the wood (e.g. 50% or 75%) harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 2a.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing environmental integrity?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 2b: Now, suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **environmental integrity**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is increased by 10 years.	☐
☐	Stumpage fees are reduced to half of current levels.	☐
☐	Operational requirements for tenure holders become more prescribed so that firms have less discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC remains at the current levels.	☐
☐	None of the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 2b.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing environmental integrity?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 2c: Now, suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **environmental integrity**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	**Worst** characteristic (Please check only one)
☐	Current duration of tenure is maintained.	☐
☐	Stumpage fees remain at current levels.	☐
☐	Operational requirements for tenure holders become less prescribed so that firms have more discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is half current levels.	☐
☐	All the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder	☐

Question 2c.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing environmental integrity?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Community stability

Promoting or maintaining community stability means that communities are vibrant places that maintain current residents and attract newcomers. Such communities are sufficiently robust that they are able to weather economic downturns and continue to prosper. Continuous and long-term jobs and income stay within the local economy.

Please think of tenure agreements in terms of community stability. Choose **one Best and one Worst** factor for maintaining or enhancing community stability.

Question 3a: Suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **community stability**, and which one is the **worst**? (Please check one answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is increased by 10 years.	☐
☐	Stumpage fees are increased to twice current levels.	☐
☐	Operational requirements for tenure holders become less prescribed so that firms have more discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is half current levels.	☐
☐	Some proportion of the wood (e.g. 50% or 75%) harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 3a.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing community stability?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 3b: Now, Suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **community stability**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is maintained.	☐
☐	Stumpage fees are reduced to half of current levels.	☐
☐	Operational requirements for tenure holders remain as currently prescribed.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC is twice current levels.	☐
☐	None of the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 3b.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing community stability?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Question 3c: Now, Suppose that the province introduces a form of tenure with the following characteristics. Which characteristic, in your opinion, is the **best** for maintaining or enhancing **community stability**, and which one is the **worst**? (Please check on answer in **each** column)

Best characteristic (Please check only one)	Tenure Characteristics	Worst characteristic (Please check only one)
☐	Current duration of tenure is reduced by 10 years.	☐
☐	Stumpage fees remain at current levels.	☐
☐	Operational requirements for tenure holders become more prescribed so that firms have less discretion and flexibility in how they pursue forestry objectives.	☐
☐	The amount of flexibility that tenure holders are allowed around their AAC remains at the current level.	☐
☐	All the wood harvested by the tenure holder must be processed at plants owned or operated by that tenure holder.	☐

Question 3c.2 Overall, how would you rate a tenure made up of this combination of characteristics in terms of maintaining or enhancing community stability?

Highly desirable	Somewhat desirable	Neutral	Somewhat undesirable	Highly undesirable
1	2	3	4	5

Section 2

In this section we will ask you to answer questions about your perceptions of the forest management agreement (i.e. forest tenure) between the Provincial Government and your company. We are interested in your opinion as an employee of your company. Please consider the likelihood of, and consequences of, possible changes to this agreement. In many of these questions you are asked to answer questions regarding the value of this tenure to your company. For these questions we ask you to consider the "value" of this tenure in terms of its influence on the long term profitability and competitiveness of your company. When you are asked about the importance of a specific attribute of the tenure, we ask that you consider the importance of this attribute relative to other attributes of the tenure. There are also several questions that ask how future changes to the tenure will affect its value to your company. In these questions it is important that you consider each change as if it is the only change being made to the tenure (i.e. all other aspects of the tenure will stay the same).

Please indicate which province you primarily work in and which type of forest tenure held by your company in that province with which you are most familiar. If the type of forest tenures that you are most familiar with is not on the list, please choose "Other" and indicate the type of tenure you would like to answer for:

Province

- ☐ **Alberta**
- ☐ **British Columbia**
- ☐ **Manitoba**
- ☐ **New Brunswick**
- ☐ **Newfoundland and Labrador**
- ☐ **Nova Scotia**
- ☐ **Ontario**
- ☐ **Québec**
- ☐ **Saskatchewan**

Tenure Agreement Type

- ☐ **Forest Management Agreement (FMA)**
- ☐ **Timber Quota**
- ☐ **Tree Farm Licence (TFL)**
- ☐ **Forest Licence (FL)**
- ☐ **Timber Sale Licence (TSL)**
- ☐ **Forest Management Licence Agreement (FML)**
- ☐ **Timber Sale Agreement (TSA)**
- ☐ **Crown Timber Licence (CTL)**
- ☐ **Long Term Timber Licence (LTTL)**
- ☐ **Long-term Licence and Management Agreement (LMA)**
- ☐ **Sustainable Forest Licence (SFL)**
- ☐ **Forest Resource Licence (FRL)**
- ☐ **Contrat d'approvisionnement et d'aménagement forestier (CAAF)**
- ☐ **Forest Management Agreement (FMA)**
- ☐ **Other:** _____

Please answer the questions in the following section of the survey with respect to the most important (e.g. largest volume or area) tenure held by your company of the type that you indicated above in the province you selected.

Please answer the following questions with respect to the security of your company's tenure. Note that we refer to the security of your tenure in terms of the agreement your company holds with the government, and not to security in terms of future conditions in the forest products market:

		Very secure		Somewhat secure		Somewhat insecure		Very insecure
2.1	I perceive my company's current tenure to be...	1	2	3	4	5	6	7

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.2	Overall, it is likely that one or more important changes in the conditions of my company's tenure will occur in the next 20 years.	1	2	3	4	5

		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.3	Considering all of the tenure changes that I think are likely to occur, it is likely that the value of this tenure to my company will...	1	2	3	4	5

		Full compensation		Partial compensation		No compensation
2.4	If changes in the conditions of my company's tenure occur, and decrease the value of this tenure to my company, the level of government compensation that my company is likely to receive is...	1	2	3	4	5

Please answer the following questions with respect to requirements that your company own and operate a timber processing facility:

2.5.1 Is your company required by contract with the Provincial Government (either as part of your tenure contract or in a separate contract with the government) to own and/or operate a timber processing facility?

☐ Yes ☐ No

If you answered "Yes" to question 2.5.1, please answer questions 2.5a & 2.6a and then proceed to question 2.7. If you answered "No" to question 2.5.1, please answer questions 2.5b & 2.6b and then proceed to question 2.7

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.5a	With respect to the value of this tenure to my company, removing the requirement that it own and/or operate a timber processing facility would be important.	1	2	3	4	5
2.6a	It is likely that the requirement to own and operate a timber processing facility will be removed from my company's tenure in the next 20 years.	1	2	3	4	5

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.5b	With respect to the value of this tenure to my company, maintaining the status quo in which my company is not required to own and/or operate a timber processing facility would be important.	1	2	3	4	5
2.6b	It is likely that the requirement to own and operate a timber processing facility will be added my company's tenure in the next 20 years.	1	2	3	4	5

Please answer the following questions with respect to the ability and right of your company to export unprocessed timber outside the province:

If you work in Manitoba or Saskatchewan, please answer questions 2.7a & 2.8a and then proceed to question 2.9. If you work in any other province, please answer questions 2.7b & 2.8b and then proceed to question 2.9

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.7a	With respect to the value of this tenure to my company, removing restrictions on exporting unprocessed timber outside the province would be important.	1	2	3	4	5
2.8a	It is likely that restrictions on exporting unprocessed timber outside the province will be removed in the next 20 years.	1	2	3	4	5

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.7b	With respect to the value of this tenure to my company, maintaining the status quo in which there are no restrictions on exporting unprocessed timber outside the province would be important.	1	2	3	4	5
2.8b	It is likely that restrictions on exporting unprocessed timber outside the province will be added in the next 20 years.	1	2	3	4	5

Please answer the following questions with respect to the ability and right of your company to sell/transfer its current tenure:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.9	With respect to the value of this tenure to my company, removing restrictions that require government approval for the sale of this tenure would be important.	1	2	3	4	5
2.10	It is likely that restrictions requiring government approval to sell this tenure will be removed in the next 20 years.	1	2	3	4	5

Please answer the following questions with respect to the rights that your company has or does not have to harvest trees and manage other forest resources:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.11	With respect to the value of this tenure to my company, gaining rights to earn revenues from forest recreation would be important.	1	2	3	4	5
2.12	It is likely that the right to earn revenue from forest recreation will be added to this tenure in the next 20 years.	1	2	3	4	5
2.13	With respect to the value of this tenure to my company, gaining rights to earn revenues from non-timber forest products, such as mushrooms and berries, would be important.	1	2	3	4	5
2.14	It is likely that the right to earn revenue from non-timber forest products, such as mushrooms and berries, will be added to this tenure in the next 20 years.	1	2	3	4	5
2.15	With respect to the value of this tenure to my company, gaining the right to receive carbon credits from forest management would be important.	1	2	3	4	5
2.16	It is likely that carbon credits from forest management will be added to this tenure in the next 20 years.	1	2	3	4	5

Please answer the following questions with respect to the length of time (duration) that your company can hold its tenure before it expires and/or renewal is necessary:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.17	With respect to the value of this tenure to my company, the duration of this tenure is important.	1	2	3	4	5
		Greatly increase	**Increase somewhat**	**Stay the same**	**Decrease somewhat**	**Greatly decrease**
2.18	It is likely that, in the next 20 years, the duration of this tenure will change, such that its value to my company will...	1	2	3	4	5
		Strongly agree	**Somewhat agree**	**Neither agree nor disagree**	**Somewhat disagree**	**Strongly disagree**
2.19	With respect to the value of this tenure to my company, the assuredness of renewal of this tenure is important.	1	2	3	4	5
		Greatly increase	**Increase somewhat**	**Stay the same**	**Decrease somewhat**	**Greatly decrease**
2.20	It is likely that, in the next 20 years, the assuredness of renewal of this tenure will change such that its value to my company will...	1	2	3	4	5

Please answer the following questions with respect to your company's AAC and the flexibility that your company is allowed around it:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.21	With respect to the value of this tenure to my company, the flexibility allowed in harvest levels around the AAC is important.	1	2	3	4	5
		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.22	It is likely that, in the next 20 years, the amount of flexibility allowed in my company's harvest levels around the AAC will change, such that the value of this tenure to my company will...	1	2	3	4	5
		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.23	With respect to the value of this tenure to my company, the AAC of this tenure is important.	1	2	3	4	5
		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.24	It is likely that, in the next 20 years, the AAC of this tenure will change, such that its value to my company will...	1	2	3	4	5

Please answer the following question with respect to the timber that your company obtains from within this tenure and from sources outside of this tenure:

		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.25	If my company were to lose sources of timber outside of this tenure, thus having to rely solely on this tenure for timber, the value of my company would...	1	2	3	4	5
2.26	If my company were to lose this tenure, thus having to rely solely on outside sources of timber, the value of my company would...	1	2	3	4	5
		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.27	It is likely that, in the next 20 years, my company will lose sources of timber outside of this tenure.	1	2	3	4	5

Please answer the following question with respect to the operational requirements of your company's tenure:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.28	With respect to the value of this tenure to my company, the amount of flexibility and discretion that it is allowed in how forestry objectives are pursued is important.	1	2	3	4	5
		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.29	It is likely that, in the next 20 years, the amount of flexibility and discretion my company is allowed in how forestry objectives are pursued will change, such that the value of this tenure to my company will...	1	2	3	4	5

Please answer the following questions with respect to the stumpage fees paid by your company for this tenure:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.30	With respect to the value of this tenure to my company, the amount of stumpage fees my company pays for this tenure is important.	1	2	3	4	5
		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.31	It is likely that, in the next 20 years, the amount of stumpage fees paid by my company will change such that the value of this tenure to my company will...	1	2	3	4	5

Please answer the following questions with respect to the market in which your company operates:

		Greatly increase	Increase somewhat	Stay the same	Decrease somewhat	Greatly decrease
2.32	It is likely that, in the next 20 years, harvesting and production costs, net of inflation, borne by my company will...	1	2	3	4	5
2.33	It is likely that, in the next 20 years, market prices, net of inflation, for my company's products will....	1	2	3	4	5

Please answer the following questions with respect to incentives for your company to invest in timber processing facilities:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.34	One or more features of my company's tenure negatively influence my company's willingness to invest in its timber processing facilities.	1	2	3	4	5

		Greatly increase	Increase somewhat	Neither increase nor decrease	Decrease somewhat	Greatly decrease
2.35	It is likely that changes to my company's tenure in the next 20 years will have the following impact on my company's willingness to invest in its timber processing facilities.	1	2	3	4	5

Please answer the following questions with respect to incentives for your company to invest in silviculture within your tenure's management area:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.36	One or more features of my company's tenure negatively influence my company's willingness to invest in silviculture within the tenure's management area.	1	2	3	4	5

		Greatly increase	Increase somewhat	Neither increase nor decrease	Decrease somewhat	Greatly decrease
2.37	It is likely that changes to my company's tenure in the next 20 years will have the following impact on my company's willingness to invest in silviculture within the tenure's management area.	1	2	3	4	5

Please answer the following questions with respect to the influence of this tenure on your company's competitiveness:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.38	One or more features of my company's tenure limit the competitiveness of my company in the global marketplace.	1	2	3	4	5
		Much more competitive	Somewhat more competitive	Neither more nor less competitive	Somewhat less competitive	Much less competitive
2.39	It is likely that changes to my company's tenure in the next 20 years will cause my company to become...	1	2	3	4	5

Please answer the following questions with respect to how this tenure allows you to introduce innovative approaches to forest practices by your company.

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.40	One or more features of my company's tenure limit the ability of my company to engage in innovative practices.	1	2	3	4	5
		Much more innovative	Somewhat more innovative	Neither more nor less innovative	Somewhat less innovative	Much less innovative
2.41	It is likely that changes to my company's tenure in the next 20 years will cause my company to become...	1	2	3	4	5

Please answer the following questions with respect to how this tenure influences the stability of local communities:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.42	One or more features of my company's tenure negatively influence the stability of local forest dependent communities.	1	2	3	4	5
		Greatly increase	Increase somewhat	Neither increase nor decrease	Decrease somewhat	Greatly decrease
2.43	It is likely that changes to my company's tenure in the next 20 years will have the following impact on the stability of local forest dependent communities.	1	2	3	4	5

Please answer the following questions with respect to how this tenure influences the environmental integrity of forests managed by your company:

		Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
2.44	One or more features of my company's tenure significantly limit the ability of my company to maintain and/or enhance the environmental integrity of forests managed by my company.	1	2	3	4	5
		Greatly increase	**Increase somewhat**	**Neither increase nor decrease**	**Decrease somewhat**	**Greatly decrease**
2.45	It is likely that changes to my company's tenure in the next 20 years will have the following impact on my company's ability to maintain and/or enhance the environmental integrity of forests managed by my company.	1	2	3	4	5